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US Army Corps of Engineers
Waterways Experiment Station

New York Bight Study

Report 4
Geographic Information System and Relational Database Management System Development

by *Matteson W. Hiland, Mark R. Byrnes*
CoasTec

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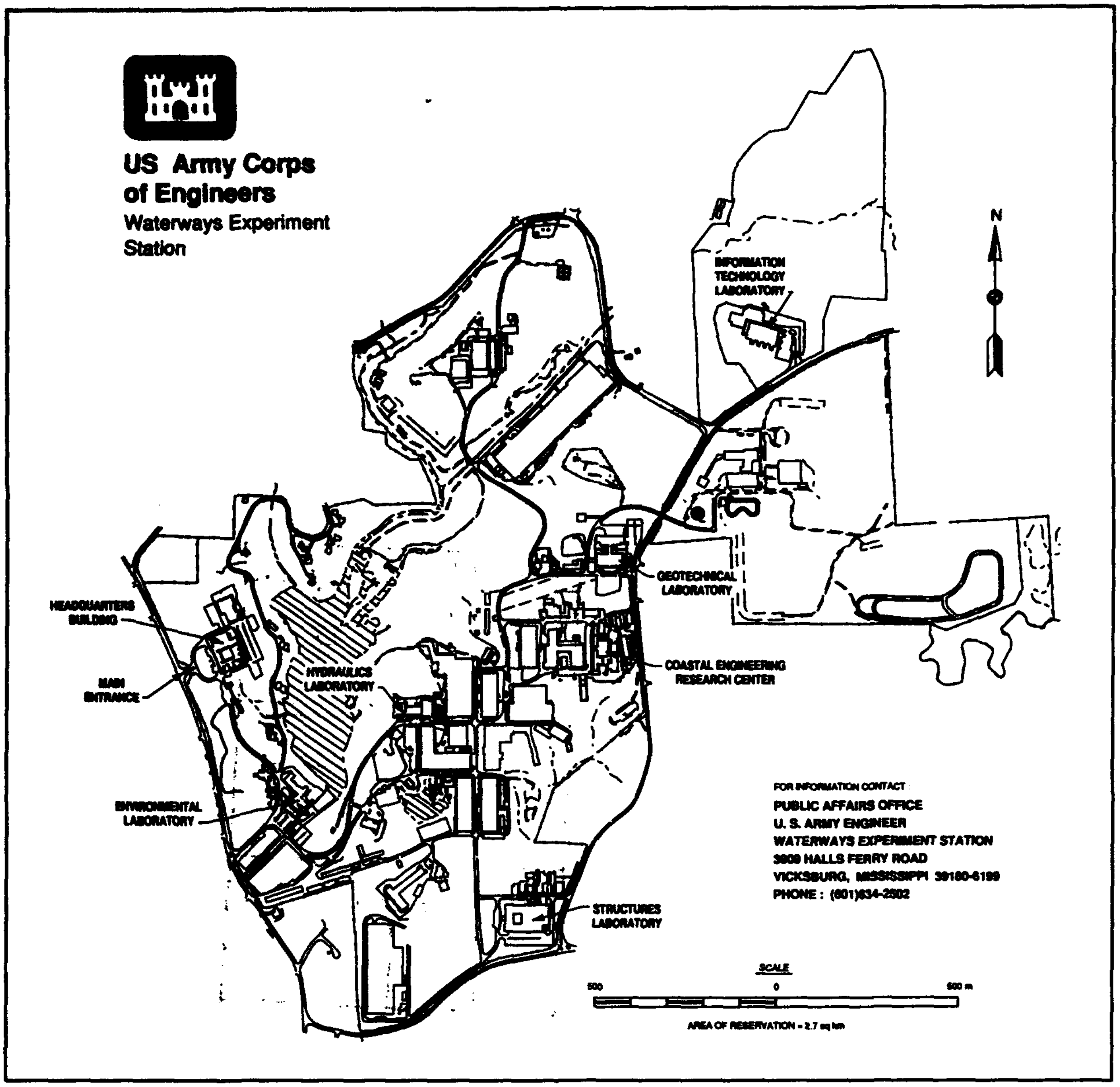

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Contents

Preface

Section 728 of the Water Resources Development Act of 1986 directed the U.S. Army Corps of Engineers to study the feasibility of a modeling, monitoring, and information system for the New York Bight for the purpose of assessing impacts to the Bight which may result from its various uses. Major Corps issues are potential uses that include ocean disposal of dredged material and possible construction of offshore coastal structures such as containment islands. The study was initiated through a series of workshops to obtain guidance. A combined hydrodynamic-environmental modeling technique, used in conjunction with a monitoring plan and geographical information system, was identified as an approach that could be used to successfully satisfy the goals of the study. This approach was adopted and the feasibility of the coupled modeling technology was demonstrated. The study proceeded with the development of several modeling, visualization, and information tools, a biological review program was conducted, recommendations for monitoring activities and equipment were made, and the study culminated with the completion of several reports on all of the products produced during the investigation.

This technical report is the fourth in a series of five key reports developed during the New York Bight Study. Geographic information system technology is used to develop a relational database management system for compilation and analysis of hydrographic and environmental data, as well as hydrodynamic model output, for the New York Bight Study (Contract # DACW39-93-C-0066). The study was performed by the Coastal Engineering Research Center (CERC) of the U.S. Army Engineer Waterways Experiment Station (WES) for the U.S. Army Corps of Engineers, New York District. Mr. H. Lee Butler, Chief, Research Division (RD), was Manager of the project at CERC, and Mr. Bryce Wisemiiler was Project Manager for the New York District. Mr. Paul Holt, formerly RD, provided significant input to system design and database development.

This report was prepared by Mr. Matteson W. Hiland and Dr. Mark R. Byrnes, CoasTec Corporation, under the general direction of Mr. Butler. The report was edited by Ms. Janean Shirley, Information Technology Laboratory, WES. Director of CERC during the study was Dr. James R. Houston, and Assistant Director was Mr. Charles C. Calhoun, Jr.

At the time of publication of this report, Director of WES was Dr. Robert W. Whalin. Commander was COL Bruce K. Howard, EN.

Conversion Factors, Non-SI to SI Units of Measurement

Non-SI units of measurement used in this report can be converted to SI units as follows:

Multiply	By	To Obtain
feet	0.3048	meters
inches	2.54	centimeters
square feet	0.09290304	square meters
square miles	2.589998	square kilometers

1 Introduction

Background

An integral part of the New York Bight Study involves development of a geographic information system (GIS) and relational database management system (RDBMS) for presentation and analysis of hydrodynamic and environmental data. This report documents design, installation, data capture, and data display of the New York Bight GIS/RDBMS.

A GIS is generally described as a system for input, storage, display, analysis, and output of spatially referenced information. This usually includes a link between graphic elements representing certain features or conditions and textual or numeric information about the features. Nongraphic data are generally stored in an RDBMS and are referred to as attributes.[1] The link between graphics and attributes is especially useful when GIS software provides access to the full capabilities of the RDBMS, including links between different tables, combinations of tables, and attachment of several database records to the same graphic element.

Recent continuous improvements in price/performance ratios of computer hardware, ease of use of GIS/RDBMS software, and increased social and legislative mandates to collect and analyze environmental data have led to widespread application of GIS/RDBMS technology in the public and private sectors. Although most previous GIS/RDBMS studies have dealt with terrestrial rather than marine data, numerous projects have illustrated the functionality and cost-effectiveness of GIS/RDBMS applications for organizing and analyzing large amounts of digital data (Ripple 1986, Siderelis 1991, Townshend 1991). Development of a marine GIS/RDBMS is the recommended approach for handling large amounts of model and prototype data compiled as part of the New York Bight Study.

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[1] Some systems store attribute information as part of the graphic object, eliminating the use of an RDBMS. However, this is new technology that is computationally intense and not widely used.

Section 728 legislation that authorized the New York Bight Study states that the study shall include:

> ... a hydro-environmental monitoring and information system in the New York Bight and New York Harbor ... that allows for the continual monitoring (at strategically located sites throughout the New York Bight and Harbor region) of the following: wind, wave, current, salinity, and thermal gradients and sea chemistry, in order to measure the effect of changes due to air and water pollution, including changes due to continued dumping in the Bight.

While the legislation gives no specifics as to the development and use of the GIS/RDBMS, it does specifically state certain types of data that should be included. Handling of these data greatly affects the design and implementation of the GIS/RDBMS.

The general objective of the information management component of the New York Bight Study is to develop a District-based system to store, manipulate, and analyze the data sets associated with and developed by the study for the U.S. Army Corps of Engineers, New York District. To accomplish this objective, the following efforts were required: database development, hardware/software acquisition, system installation, input of database attributes and graphic elements, and training of New York District personnel. Development of the GIS/RDBMS will complement existing New York District digital databases. Integration of data from past and present monitoring efforts is an important part of database design.

Specific tasks related to development and installation of the GIS/RDBMS included the following:

a. Implement hardware and software platform acquisition in the initial phase of work, and evaluate the necessity of additional equipment to permit adequate graphics display and analysis capabilities for model results presentation.

b. Develop the RDBMS for application with GIS software using Oracle data management software. Incorporate principal data sets within the RDBMS, including the Coastal Engineering Data Retrieval System (CEDRS) regional database for the New York Bight (developed under the Coastal Field Data Collection Program), hydrodynamic and water quality data acquired by contract for model validation, model output from specified simulations, and information developed by Hunter College for inclusion in the New York District GIS.

c. Deliver and install GIS/RDBMS software and accompanying data sets at the New York District. This task includes development of a training course and manual for assisting New York District personnel in use of the system. Training included a sample project for demonstrating system operation, its ability to organize, display,

and analyze both spatial and tabular data, and how system software typically would be applied to a specific problem related to the New York Bight Study.

d. Document the construction and application of the GIS/RDBMS in a final report. Documentation is geared to providing detailed work flow procedures for common tasks, a training manual for system use, and quick reference cards for efficient application of system software.

System Reference Terms

Throughout this report, primary technical terms used to describe the GIS/RDBMS, including data characteristics, are referenced when identifying specific functions of the system. To minimize confusion, the following mapping and GIS terms are defined for clarity.

Attribute: Non-graphic information associated with a point, line, or area element in a GIS.

C: High-level programming language used in computation and graphics.

Database: Collection of interrelated information; a GIS database includes information about the location and attributes of geographical features that have been coded as points, lines, areas, pixels, or grid cells.

Database management system: Set of computer programs for organizing information stored in a database.

Digitize: To encode map features in digital form.

Element: Fundamental graphical unit of information, such as a point, line, area, or pixel.

Network: Two or more interconnected computer systems for the implementation of specific functions.

Platform: Hardware and/or software devices used for data compilation and analysis.

Raster: Regular grid of cells covering an area, of which each grid cell, or pixel, is assigned a single value. Raster data have the advantage of easy temporal comparisons between two sets of information; however, file sizes typically are large.

Relational database: Method of structuring data in the form of sets of records so that relations between different entities and attributes can be used for data access and transformation.

Surface model: Quantitative representation of attributes describing a physical or artificially created surface in digital form.

Topology: Mathematical procedure for explicitly defining spatial relationships.

Vector: Quantity having both magnitude and direction. Vector data are stored more efficiently than raster data and have the potential for higher accuracy. However, comparisons between vector data require higher levels of computation.

Scope

The following section provides details on hardware and software configuration for the GIS/RDBMS. System development is then addressed by providing basic information on capabilities and operation of the software, and presenting detailed information on the data included and its organization within the system. A brief description of training and maintenance requirements for New York District personnel is given with reference to New York Bight Study data. Appendix A is a user training guide for the New York Bight GIS/RDBMS.

2 Hardware/Software Requirements and Configuration

Hardware and software requirements for the New York Bight GIS/RDBMS were initially outlined through a series of meetings in September and October, 1991. Guidelines were identified that controlled selection of hardware and software, as well as development and implementation of the GIS/RDBMS. The following system requirements were identified to meet New York District needs:

a. Hardware must have sufficient primary and secondary memory to store, display, manipulate, and analyze large amounts of data acquired as part of the New York Bight Study for manipulation within the GIS/RDBMS.

b. The system must maintain compatibility with other U.S. Army Corps of Engineers GIS/RDBMS projects, and conform to Federal standards for geographic data.

c. The GIS/RDBMS software shall provide for input, storage, display, analysis, and presentation of graphic and attribute data.

d. The system shall provide easy access to graphic and attribute data via a graphical user interface.

e. The GIS/RDBMS software shall provide for organization and management of graphic and attribute data.

f. The RDBMS software shall be Oracle, to maintain compatibility with CEDRS and other data sets.

g. The GIS shall provide an interface with Oracle and have the capability to take full advantage of the functions of the RDBMS.

h. The hardware shall include provisions for upgrading software, loading data from other sources, and performing regular backups.

Hardware and software implementation were directed using these basic requirements, and system configuration was designed for integration of field data sets and numerical modeling results for project planning and management.

Hardware Configuration

Intergraph hardware and software were chosen as the system platform for the New York Bight GIS/RDBMS (Table 1). After evaluating system options, an Intergraph InterPro 6480 with a configuration of 48 MB random access memory (RAM), 1 GB disk storage, and a 27-in.[1] color monitor was selected to address New York District needs. Primary memory requirements are needed for complex operations on large data sets, whereas secondary memory (disk storage) is necessary for storing large data sets and several software products. The workstation uses EDGE II graphics (24-bit), which provides high-quality graphics for GIS production and/or image-processing functions. The large size of the monitor enhances the user's viewing capabilities, and is especially useful for digitizing and project demonstration purposes.

A 36-in. by 48-in. digitizing board was attached to the InterPro 6480 via a digitizer controller. This allows input of new data from maps. A Compact Disc-Read Only Memory (CD-ROM) reader was included because this is the preferred method of Intergraph software distribution. Also, data sets from various sources (e.g., U.S. Geological Survey (USGS), U.S. Bureau of the Census, National Oceanographic and Atmospheric Administration [NOAA]) are currently available on CD-ROM for integration with GIS/RDBMS projects. A read/write optical disk drive was included for increasing on-line storage capabilities, and a 2.3-GB tape drive (8 mm) was added for backups and transfer of data. Finally, a Calcomp Draftmaster plotter was required for making hardcopy output of products generated from the GIS/RDBMS.

Software Configuration

System software for the New York Bight GIS/RDBMS includes Unix, TCP/IP, and XNS (networking software), Distributed System Management

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[1] A table of factors for converting non-SI units of measurement to SI units is presented on page v.

Table 1
Hardware and Software for the New York Bight GIS/RDBMS

Item	Description
Hardware	
Intergraph InterPro 6480	UNIX workstation with 48-MB RAM, 1-GB disk storage, single 27-in. monitor with EDGE II graphics
CD-ROM	Peripheral for loading software and data from compact disc
8-mm tape drive	Backup and data transfer device with 2.3 GB per tape
Digitizer	36-in. by 48-in. digitizing table for input of data from large maps
Read/Write Optical Disk Drive	Peripheral for on-line storage and off-line archival of large data sets
CalComp Draftsmaster	400-DPI thermal gray scale plotter
Software	
MicroStation 32	CADD software and basis for other graphic applications
MGE_SX	Base GIS and RDBMS interface software
MGE Modeler	Surface modeling software
MGE Grid Analyst	Creation, editing, manipulation, display and analysis of grid files
MGE Analyst	Vector GIS analysis package
Projection Manager	Conversion between coordinate systems
I/RAS 32	Raster file display and editing
Oracle RDBMS	Nucleus database management product
Oracle SQL Plus	Database query and report interface

(DSM - system maintenance utilities), and Relational Interface System (RIS). RIS is a package that provides a common language interface to several industry-standard relational database management systems. It is used extensively by the GIS software to submit Structured Query Language (SQL) statements to the RDBMS.

Oracle was selected for use with the New York Bight Study because it is one of the more common relational database management systems that provides comprehensive relational database functions and data storage capabilities. It also takes complete advantage of networking technology, allowing several users to access the same database simultaneously. Oracle SQL Plus provides an interface for querying the database and producing reports.

MicroStation is one of the leading Computer Aided Drafting and Design (CADD) packages. It provides data entry, viewing, and manipulation functions, as well as MicroStation Development Language (MDL), a programming language based on C that enables full access to MicroStation commands for customization. Intergraph's graphic applications software

products are based on MicroStation graphics and operations, and many are actually programmed using MDL.

Modular GIS Environment Single-User Nucleus (MGE_SX) is the core software platform upon which all application software operate to create a GIS. It serves to logically organize project data, provides for graphic and attribute data input, and has a user-friendly interface for graphic display. Perhaps most importantly, it supports a powerful and easy-to-use interface to the RDBMS. MGE_SX has utilities for building tables, creating table joins and views, and managing, organizing, and populating the database. It also controls linkages between graphics and the database, and provides access to the RDBMS via graphics as well as access to graphics via RDBMS commands.

Additional software products integrated through MGE_SX as part of the GIS platform provide spatial analysis and map projection utilities. MGE Analyst (MGA) is a vector spatial analysis package. MGE Projection Manager (MPM) is very useful during data input and presentation phases of a project. It converts graphic files between many different map projections and horizontal datums, and enables creation of latitude-longitude and/or x-y grids. MGE Grid Analyst (MGGA) includes functions for creation, manipulation, and analysis of grid files. MGE Terrain Modeler (MTM) incorporates surface modeling capabilities for analyzing 3-D data. I/RAS 32 provides for input, display, and editing of raster files such as scanned images and satellite data. All of the graphic application products are integrated under a single, user-friendly interface, and all applications are simultaneously accessible. This leads to a reduced learning curve and increased productivity.

Maintenance

Efficient operation of the GIS/RDBMS requires a commitment to system maintenance. This includes securing hardware and software support from Intergraph, as well as dedicating personnel for tasks such as software upgrades and regular backups. Intergraph's hardware maintenance program provides repair or replacement, including parts and labor, of any equipment covered on a maintenance contract. The software maintenance program provides technical support for all products covered on a maintenance contract. Equally important, software maintenance ensures delivery of all new versions of software products. It is important to upgrade to current versions of software to take advantage of improvements and new features, and to retain compatibility with other users.

Because GIS/RDBMS system operations require full-time attention, at least one New York District computer engineer should attend Intergraph's system management training course. This person will be responsible for regularly scheduled backups, software updates, disk space management, and general problem-solving. Efficient system operation will depend on

the level of support given through hardware and software maintenance and proper system management.

3 GIS and RDBMS Development

A GIS is defined as a system for input, storage, display, analysis, and output of geographically referenced data. It must be able to capture original data from various sources and of various types, and store them in an organized manner. The system must then combine these various data, analyze the results of these combinations to produce new information, and produce maps of the original and new information. Although it is not required by definition, a GIS is generally assumed to be a computerized system. Computer graphics and processing provide more efficient means for accomplishing the functions of a GIS than do manual methods. Computers also allow the graphics to be linked with an RDBMS, augmenting the graphics with added information for use in analysis. In other words, rather than simply analyzing spatial relationships between graphic elements, one can also analyze according to relationships between associated attribute data. This section provides a summary of the concepts and organizational structure of Intergraph's MGE used in this study to develop the New York Bight GIS/RDBMS.

Software Organization and Concepts

The basis for all of Intergraph's GIS software is the MGE Single User Nucleus (MGE_SX). This platform provides the mechanism for data input and the organizational framework in which it is stored. MGE_SX structures data into **projects, categories,** and **features**. A project is the top level division of data, and contains all data related to a particular task. For example, the New York Bight GIS/RDBMS is created as an MGE_SX project. A **category** is a general type of data, while a **feature** is a specific component within a **category**. For example, if the **category** is *coastal engineering structures,* there might be several **features** such as *groin, seawall, jetty,* or *breakwater.* Thus, a **category** may contain several **features**, but a **feature** may only belong to one **category**. A database schema contains a group of categories and features specific to a project. Different

projects may have the same schema if the projects are divided geographically but contain the same types of data.

Within MGE_SX, the user creates projects and schemas, defines categories and features, and performs several graphics and database utilities. A feature table is built that contains information about each feature to be digitized. This table includes the feature name, its category, type (point, line, area boundary, or area centroid), color, weight, style, level, and placement command. During digitizing, MGE_SX uses this table to automatically place features consistently and correctly. In addition, once a feature has been placed in a file, only features from the same category may be placed in that file. This organization of features assists in preventing erroneous placement of elements. Figure 1 shows relationships between the various files, categories, and database tables in MGE_SX.

Intergraph's Relational Interface System (RIS) is another integral software module used in the New York Bight GIS/RDBMS. RIS works in conjunction with MGE_SX to provide linkages to several commercially available RDBMS's, including Oracle, Informix, and Ingres. RIS provides a single interface to all supported RDBMS's that is transparent to the user (ie., the user is not required to be an expert in database structure or language to perform queries and analyses) and allows simultaneous access to several different databases. In addition, all aspects of operation are menu-driven for intuitive application of database functions. It takes complete advantage of networking technology, allowing several different networked workstations access to the same information.

All non-graphic information used by MGE_SX is stored in a database table. A unique set of database tables may be created for each project, or the same set may be used for several different projects if similar data are being processed. Typically, one database table is established for each category, because all features within a category will have similar attributes. The categories, features, database tables, and attribute fields are designed and defined prior to data capture.

MicroStation is the CADD software that allows placement of graphic elements in a specific coordinate system, placement of text and labels, and complete 3-D drawing capabilities. MicroStation provides the base graphics software on which the GIS application software modules operate (Figure 2). MPM is a software package that is used to set up files with coordinate systems that match those present on maps being digitized. After cartographic data are digitized, MPM provides transformation routines to convert all maps to a common datum and projection, so that they can be correctly compared.

After maps have been digitized and checked for errors, MGA is used to build a topological file for performing spatial and relational vector analysis. This means that all spatial relationships between elements to be analyzed are stored in a single file. Then queries are built using a graphical interface. These queries can be combinations of spatial queries and SQL

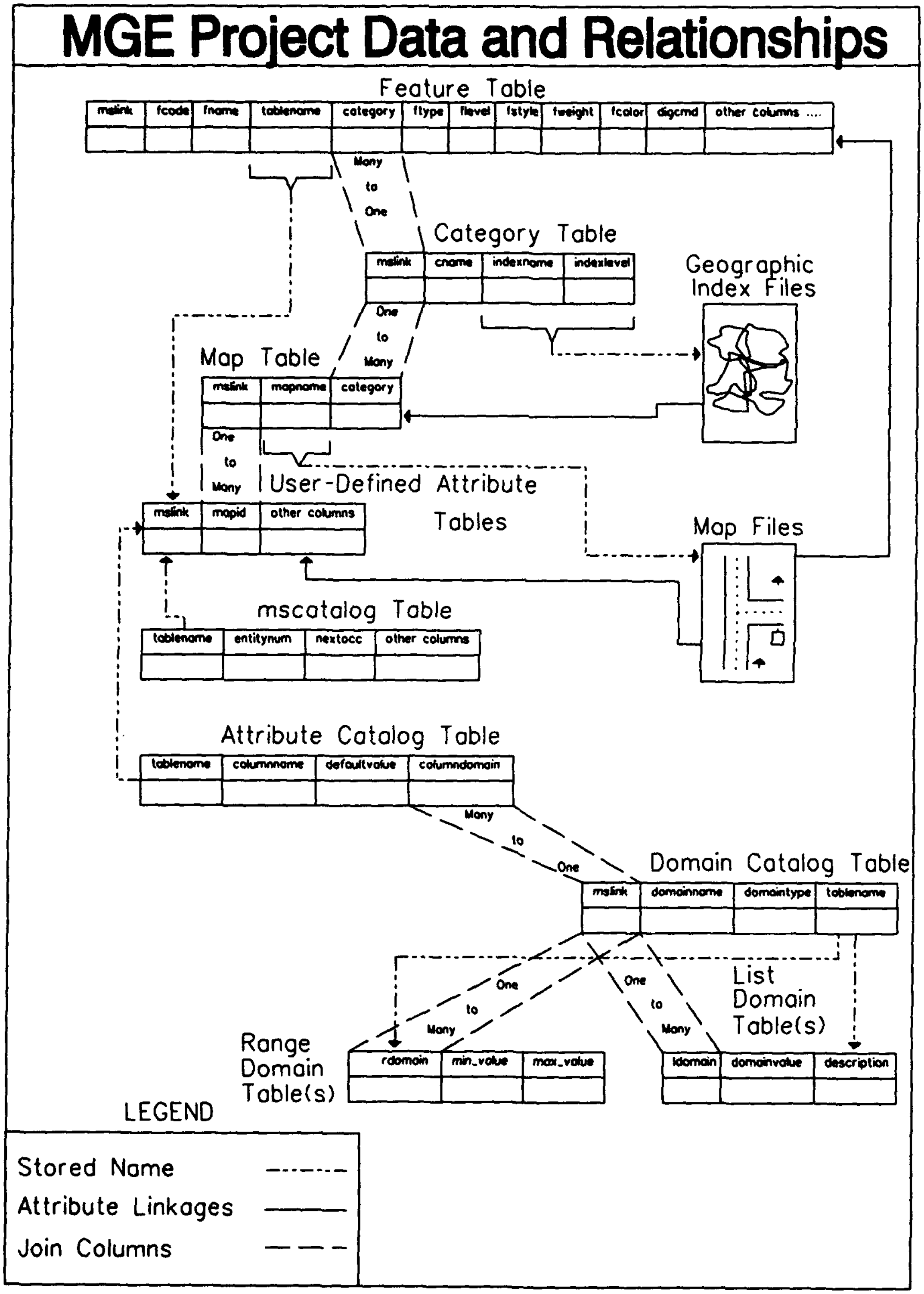

Figure 1. MGE_SX project data and relationships (after Intergraph Corporation (1991))

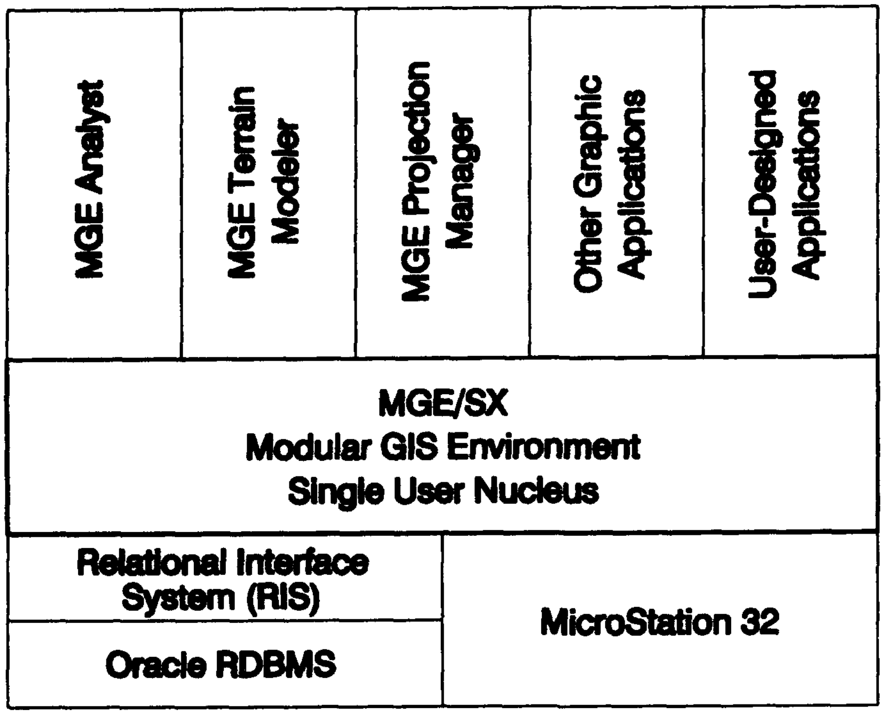

Figure 2. MGE software module relationships (after Intergraph Corporation (1991))

searches in the database. New files and maps can then be produced from the output of these queries.

MTM is the surface modeling module in the MGE environment. It allows input of point data and contour data digitized from maps, as well as digital data from magnetic media. Any data set of parameters associated with specific locations can be processed and compared using MTM, including topography and bathymetry, salinity, temperature, suspended sediment, and others. A Triangulated Irregular Network (TIN) file is created after definition features are input. Additions and subtractions of surfaces can be performed, as well as interactive editing of the files. Output includes new TIN files, grid files, or design files showing features such as contours and spot elevations.

MGGA is the software module for spatial analysis of grid files. Data from various sources can be input, edited, classified, and combined. Analysis functions include implementations of Intergraph's Geographic Oriented Analysis Language, as well as the Map Algebra Command Language (Tomlin 1990). Potential grid file sources include satellite imagery, scanned photographs and maps, and MTM output.

I/RAS 32 is a software package for the input, display, and editing of raster files, as well as conversions between various raster formats. Some examples of data used with I/RAS 32 are scanned images and satellite data.

MGE Project Data Organization

MGE_SX has its own directory structure that is automatically built when a project is created. Other graphic applications are integrated within this structure. Within the software, a directory is identified as the project directory and is usually named **/usr/mgeprj**. Under the project directory, MGE_SX creates a new directory for each project. The software can identify available projects by directory names. All files used by MGE_SX and other applications for the New York Bight Study are stored under the **/usr/mgeprj/%nybyte** directory (Figure 3). Under the project, 18 directories are created:

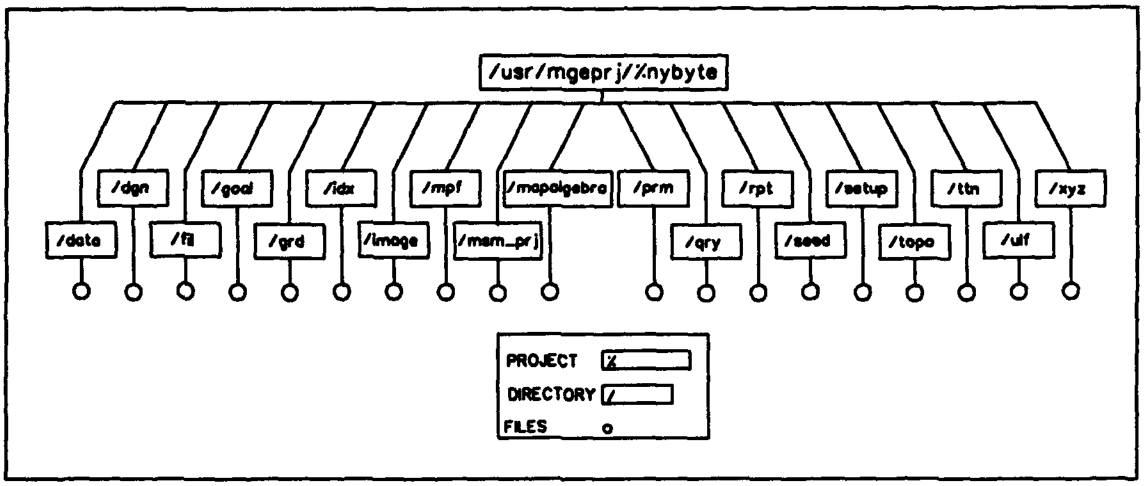

Figure 3. MGE project directory structure (after Intergraph Corporation (1991))

/data: Contains a variety of raw data files from which graphic files were created and database tables were populated. (This directory is not automatically created by MGE_SX, but is often added to help organize source data.)

/dgn: Contains all design files. These are also referred to as map files, because the data set contained in them is normally a map for GIS work. If a new map file is created while in a particular project, it is placed in this directory.

/fil: Contains convolution filters used by MTM. Convolution filtering is the process of averaging small sets of pixels or grid cells to enhance certain qualities of the data. Common applications include smoothing, edge detection, and edge enhancement.

/goal: Contains script files written in Intergraph's Geographic Oriented Analysis Language. These are files used in

MGGA to define operations performed on input grid files for creating output grid files.

/grd: Contains grid files. Any grid files created with MTM or MGGA are stored in this directory.

/idx: Contains index files. These are files used in Feature Display Management, a utility for locating and displaying maps that cover an area interactively defined on a vicinity map.

/image: Contains all satellite imagery files. This directory is also often used to store data from scanned maps or photos.

/mapalgebra: Contains scripts written using the Map Algebra Command Language. These are used in MGGA to define operations performed on input grid files for creating output grid files.

/mpf: Contains model parameter files for use by MTM. These control the display and output of TIN and grid files.

/msm_prj: Contains MTM project files. These contain global defaults for creation of a new model.

/prm: Contains parameter files used by MPM. When creating latitude-longitude or x-y grids, a file containing bounding coordinates, grid line spacing, text size, and other parameters can be saved for future use.

/qry: Contains query files. SQL statements used to analyze topological files can be saved as ASCII text strings for future use. These are placed in this directory.

/rpt: Contains report files. When queries are built, a report of the findings of the queries can be output to an ASCII file, which is stored here.

/seed: Contains seed files. Seed files are empty map files that are set up with specific coordinate systems and other graphics environment settings. These are used to create new map files.

/setup: Contains various files used by the MGE_SX software to control the MGE environment. Also contains cell files that are used to place symbols or groups of elements as a single element.

/topo: Contains topologically structured files created by MGA.

/ttn: Contains *.ttn* files created by MTM. These files hold the definitions of triangulated irregular network representations of three-dimensional surfaces, and are loaded into memory when working with MTM.

/ulf: Contains Universal List Files. These are files that contain a list of all elements in a graphics file, their element types, coordinate positions, and other information. These are used by graphics and attribute processing applications such as Line Cleaner and Bulk Update.

/xyz: Contains *.xyz* files used by MTM. These are binary files containing x, y, and z values for points. MTM uses these files as a primary means of transferring data to and from other applications.

Data Sets

This section discusses the content of various data sets within directories of the New York Bight GIS/RDBMS. Explanations of graphics file and database table contents, data history, and procedures used for input of data are included.

Coordinate system setup files. The selection of a base map projection and coordinate system was one of the first decisions made in the process of loading graphic data. All files must either be created in or converted to the same set of cartographic parameters in order to establish appropriate overlays. NOAA Chart No. 12300 (scale equals 1:400,000), was used as the basis for all map files in the project. A Mercator projection was established to match all parameters on the NOAA chart. The map origin was set at longitude -72° and latitude 40°, with a false easting and northing of 2,000,000 m. This set of parameters was saved in a seed file named *seed2d.dgn* in the directory **/usr/mgeprj/%nybight/seed**. A seed file is a design file that contains coordinate system parameters. Instead of performing the design file setup each time a file with the same coordinate system is created, a seed file is copied to the new file, reducing time and errors. Other seed files are *seed3d.dgn*, which has the same cartographic parameters, but is used for 3-D design files, and *aseed.dgn* (see next section). Working units are in meters, and there are 1,000 units of resolution per meter.[1]

Digital Line Graph (DLG) data. The USGS publishes graphic map data in the DLG format at various scales covering the entire United States.

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[1] See Appendix A (page A12) for a detailed description of working units.

Infrastructure, boundary, and water body data included in the New York Bight Study were obtained from a USGS CD-ROM containing DLG files at 1:2,000,000 scale. These data are divided into regions of the United States, and two regions were needed to cover the study area: region 1 (northeast) and region 2 (mid-Atlantic). The data extracted include political boundaries, roads and trails, streams and rivers, water bodies, and railroads. The DLG data files are stored in the **/usr/mgeprj/%nybyte/data/dlg/raw** directory. File names are *s01_**.lgo* or *s02_**.lgo*, where 01 or 02 indicates the region, and ** is replaced by *pb* (political boundaries), *rd* (roads and trails), *st* (streams and rivers), *wb* (water bodies), or *rr* (railroads), depending on need. These files have been compressed using the Unix compress command, which appends a .Z to the end of the file name. To uncompress, key in **compress -d /usr/mgeprj/%nybight/raw/***.Z at the Unix prompt.

DLG files were translated to Intergraph format using the MGE GIS Translators (MGT-US) software at the U.S. Army Engineer Waterways Experiment Station (WES) Coastal Engineering Research Center (CERC). A seed file was established (*aseed.dgn*) in the **%nybight/seed** directory to match the Albers Equal Area Projection used for the DLG files. DLG data were loaded into design files located in the **/usr/mgeprj/%nybyte/data/dlg/albers** directory. The files are named *a**01.dgn* or *a**02.dgn*, where *a* stands for Albers, ** represents *pb*, *rd*, *st*, *wb*, or *rr*, and *01* or *02* denotes the region. These *.dgn* files were then converted to the Mercator projection described above and stored in the **%nybight/dgn** directory as *political.dgn*, *water.dgn*, and *rivers.dgn*. Data from the two regions were edge-matched and joined, and data outside the study area were deleted. The maps derived from DLG data have no database attributes attached. Another file, *shoreshape.dgn*, contains a copy of the DLG shoreline that has been cleaned, has closed polygons created, and has centroids placed. There are no feature or attribute linkages, but they could be added to this file for color-filled display and output of the shorelines.

Other shoreline data. Two other files located in the **%nybyte/dgn** directory contain shoreline data. These are *nyharb.dgn* and *westhamp.dgn*. They were digitized from 1:40,000 nautical charts and provide more accurate shoreline locations than the DLG files. However, these cover only limited areas whereas the DLG data cover the entire study area. The files have no database attributes attached.

Bathymetry data. The file *bathym.dgn* in **%nybyte/dgn** contains bathymetric contours for the New York Bight. These are derived from water depths at the corner points of New York Bight Study grid cells (based on data obtained primarily from a 1:400,000 scale chart; some nearshore data were taken from larger scale charts).

Tide data. The file *tides.dgn* in **%nybyte/dgn** contains graphic representations of 10 tide gauge locations in the study area. These are MGE identified as "tide_gage." Tide gauge station IDs, latitude-longitude locations, and city-state locations are stored in the table "tide_guage"

(misspelling is actually recorded as the table name). Another table, "apr76_tides," contains hourly tide information for the month of April 1976, including station ID, record number, date and time, and tide level. The two tables are joined in a relational view named "tides," so that all tide information can be accessed simultaneously.

New York Bight study grid. Two design files in the **%nybyte/dgn** directory represent the computational grid for the New York Bight Study. These graphics have no feature or attribute linkages. The file *grd_pts.dgn* contains only the grid corner points. The file *nybgrid.dgn* contains the lines that delineate the grid. This is the same grid used for the hydrodynamic and water quality modeling portions of the study. The original grid was laid out on NOAA chart No. 12300. The corner coordinates were originally in feet and referenced to an origin point of longitude -76° and latitude 38°. A BASIC program was written to convert the corner coordinates to files that were read into MicroStation using the *adftoxyz* translator. The files were read into MicroStation files with cartographic parameters matching the NOAA chart, and then converted to the Mercator projection used for this project. All files relating to the New York Bight grid, other than these two design files, are located in **/usr/mgeprj/%nybyte/data/hydgrid**.

Image data. Two satellite images are located in the **%nybyte/image** directory. The first is a SPOT image of New York City, obtained from Arc/Info training data. Pixel size is approximately 20 by 20 m. The data are in raw format, and the image was registered to NOAA charts of the area using a simple affine transformation. The second image is Advanced Very High Resolution Radar data from a CD-ROM published by USGS. The files with *.cot* extension are the original data from the CD-ROM, and are rectified to the Lambert Azimuthal Equal Area projection using an affine fit. This rectification was not satisfactory, and a second order mapping polynomial was used to give a better fit in the New York Bight Mercator projection. The bands represented are: (1) red; (2) near infrared; and (3) thermal infrared. The composite image is a 2,3,1 false color composite.

Water quality model data. The file do.holt in **/usr/mgeprj/%nybyte/data/watqual** contains dissolved oxygen output from the water quality model. Other useful parameters also are available. These data represent the average dissolved oxygen values in each cell for a particular month. The time slices included are April to September, 1976. The model is run on the same grid as the hydrodynamic models, but some of the rows and columns along the coast and continental shelf are excluded. The dissolved oxygen grid is 74 by 44 cells.

Water surface elevation, temperature, and salinity. Two data files contain time slices of model output for these parameters. *NYB.SNP44168* contains raw model data from August 2, September 1, and October 1, 1976. *NYB.5453* contains raw model data for July 31, 1990. Some of these data have been extracted to *.adf* files and converted to *.xyz* files. The raw model data and *.adf* files are located in the

/usr/mgeprj/%nybyte/data/hydro directory. The *.xyz* files are located in the **%nybyte/xyz** directory and include salinity maps (*sa01_0976.xyz*, *sa10_0976.xyz*), a temperature map (*te10_0976.xyz*), and a water surface elevation map (*wse_090176.xyz*) for September, 1976. The files can be displayed, manipulated, and analyzed using MTM.

Wave Information Study (WIS) data. Hindcast wave data covering a 20-year period are included for 16 stations in the New York Bight. Station locations are given by points in the file **%nybyte/dgn/***wis_stns.dgn*. The graphics are linked to the attribute table "wis_stats." This table contains information about station location, water depth, and 20-year averages and maximums of several wind and wave parameters. Two other database tables are attached to the WIS stations through relational views. The table "wis_monthly" contains monthly averages for each station. The table "wis_6203" contains all WIS data for March 1962. WIS data are also available in CEDRS. WIS data files used to populate the database tables are located in **/usr/mgeprj/ %nybyte/data/wis**.

Ship observation data. There are five sets of ship observation data. The original data are located in **/usr/mgeprj/%nybyte/data/shipdat**. The graphics file **%nybyte/dgn/***ship76.dgn* contains points representing the locations of the observations. Attribute table "ship76" is linked to these points and contains the latitude/longitude position for each observation. Table "ship76_dat" contains the actual data recorded and is linked to table "ship76" through a relational view.

NOAA data. The design file **/usr/mgeprj/%nybyte/***noaa_stns.dgn* contains points at the locations for 10 NOAA buoys. The table "noaa_stns" is attached to these points and gives the latitude-longitude position, water depth, and start and end dates of data available for each station. Additional environmental data from NOAA buoys will be linked to this table by a relational join.

Data compiled by Hunter College. The Marine Science Research Center at Hunter College, City University of New York, has been under contract to the New York District to compile several data layers in a GIS for the New York Bight. A report was produced that contains information such as bathymetry, shipwrecks, fisheries, benthic biomass, sediment chemistry, water velocity and direction model output, and shipping lanes (Bocuniewicz et al. 1991). These data were intended to be included in the New York Bight GIS/RDBMS, as expressed in the original scope of services. However, there has been some difficulty in obtaining the data sets from Hunter College. Because these data are not available at this time, they have not been included in the GIS/RDBMS for the New York Bight Study.

4 Application of GIS/RDBMS

The types of projects that have made use of GIS/RDBMS technology for data compilation, analysis, display, and storage are widely varied. Specific areas of application include forestry, land use planning, environmental impact studies, shoreline and seafloor change analysis, site selection for offshore disposal sites, oil spill response, and many others. The kinds of projects that can be addressed by information generated for the New York Bight Study include, but are not limited to, evaluating spatial changes in physical, chemical, and biological parameters in response to natural and human processes (e.g., Hecht (1991)), assessing the impact of dredging and channel maintenance on regional bathymetric change (e.g., Byrnes and Hiland (1993)), and monitoring trends in sediment dispersal patterns associated with offshore mud disposal sites (e.g., Hansen et al. (1992)). In addition, because much of the information generated from the New York Bight Study is model output related to water quality and hydrodynamic parameters, spatial comparisons among field and model data surfaces provide a means for evaluating the effectiveness of simulations on a local or regional scale.

One of the primary benefits of applying GIS/RDBMS techniques to this project is the conversion of model data, traditionally used in tabular format, to a format that can be displayed geographically. Producing maps and making spatial overlays of different environmental parameters and/or time slices of numerical model output provide an integrated method of data comparison and analysis. In addition, the interface with the RDBMS takes advantage of the benefits of tabular data query and review.

Project-Oriented Training

In recent years, improvements have been made in the ease of use of many GIS and RDBMS products. In particular, the Intergraph system developed for the New York Bight GIS/RDBMS provides a user-friendly interface that greatly enhances the learning curve for end-users. However, the GIS/RDBMS is composed of a number of software products, each having numerous functions that may or may not be applicable to a particular project. In addition, when these products are used to integrate several

different types of data, the system and projects performed become much more complex. A user attempting to independently learn all of the software products and determine the applicable functions of each would require a significant amount of dedicated time and resources. This results in decreased efficiency in learning the software and detracts from demands of other projects. A user attending vendor-supplied training for each software product would realize some time savings, but substantial monetary costs in travel and training fees would be incurred.

A more efficient solution to this dilemma is to acquire onsite training that is oriented towards the types of projects being performed. This project-oriented training approach combines the knowledge of experts in use of hardware and software products with that of experts in a field of application. As such, two 2.5-day training courses conducted at the New York District provided basic instruction in use of each software product associated with the New York Bight GIS/RDBMS. Specific instruction was provided in the most applicable functions of each product, particularly as they relate to hydrodynamic and water quality model output, field observations, and surface modeling. This type of training encourages further exploration of the capabilities of the GIS/RDBMS by way of the user-friendly menu interface. The following discussion provides an overview of the components of project-oriented training sessions conducted as part of the New York Bight GIS/RDBMS (see Appendix A, New York Bight GIS/RDBMS User Training Guide).

Basic workstation operations. A brief review of primary operating system commands and features was given. Topics covered included login and logout procedures, opening command windows, movement and arrangement of command windows, and the console message window. In addition, basic UNIX operations, such as the **.profile** file, *ls, cd, Free*, and *ps* were discussed. An overview of the DSM product was provided to clarify procedures for performing backups and other rudimentary system management routines.

MicroStation operations. A brief review of MicroStation commands covered subjects critical to overall operation of the GIS/RDBMS. These included panel and pull-down menus, level manipulation, view manipulation, working units, active symbology, and reference files.

MGE_SX functions. Because MGE_SX is the basis for all other applications, its organizational concepts and operation were covered in detail. Important concepts presented included relationships between software packages, creating and modifying a project, project organization, entering the graphics environment, and data structure. Specific functions covered included GeoDatabase Locate, Select Map, Feature Display, Change Map, and Design File Display, all critical procedures for efficient operation of the GIS/RDBMS.

Projection Manager functions. The most important aspect of Projection Manager, and one of the most critical topics of the entire course, was

definition of coordinate systems and conversion between different coordinate systems. The entire basis for use of a GIS is the defined coordinate system under which all analyses are conducted. This was covered in detail, along with generation of graticules (x-y grids in geographic coordinate systems).

MGE Terrain Modeler functions. MTM was used to load point data into surface models for comparison with other types of data. Loading features from .xyz files, converting to TIN and grid models, and displaying TIN and grid models were addressed in detail. Output of grid and vector files from surface models was covered with reference to specific New York Bight Study data sets (e.g., bathymetry, water temperature, salinity).

MGE Grid Analyst functions. Because much of the data included in the New York Bight Study can be well-represented as grid files, considerable emphasis was placed on the use of MGGA. Basic display, manipulation, and analysis of grid files was discussed, as well as conversion of data to and from other formats.

I/RAS 32 functions. I/RAS 32 provides capabilities for display and editing of raster files (e.g., satellite images, scanned photography or maps). Functions discussed included loading, displaying, overlaying with vector displays, and saving raster files of various input and output formats.

Sample Project

The main focus of project training was to create geographic map displays from measured data and model output, and to perform analyses on these data. Training was performed in a manner that reflects the types of projects undertaken by the New York District and addresses problems or questions of interest to the New York District.

A portion of the project entailed creating a grid map of salinity and temperature from numerical hydrodynamic model output. Similar maps were created from ship observation data for making spatial correlations. Comparison of parameter surface models isolated regions of good and/or poor correlation between model results and observed data. In addition, water quality information was analyzed using similar procedures to find correlations between spatial changes in water quality and other parameters such as salinity, temperature, velocity, and waves, and their potential impacts on the placement of offshore dredged material disposal sites. These analyses were performed as example applications of the GIS/RDBMS related to the New York Bight Study, and do not reflect specific study results or recommendations.

Because potential uses of the New York Bight GIS/RDBMS are numerous, emphasis was placed on future project applications. Some specific projects associated with dredged material disposal, offshore borrow areas,

navigation problems, mapping environmentally sensitive areas, economic impacts, shoreline and seafloor change, and drafting of engineering project construction drawings were identified within the context of New York Bight Study objectives.

5 Summary and Recommendations

The New York Bight GIS/RDBMS is a logical approach to organizing and analyzing varied data sets and model output produced by the New York Bight Study. Well-organized and documented information in a digital format can be combined with data from future studies more efficiently than traditional analog procedures. Because this information is now organized in digital format, project planning questions can be evaluated against all existing data in an accurate and timely manner. Development of the New York Bight GIS/RDBMS has led to more effective use of resources by avoiding duplication of effort and providing instant access to key files and modeling data sets for regional analysis of trends, as well as local assessment of engineering impacts. Also, the graphical user interface provides an easy means of accessing data such as WIS and other model output in both graphic and tabular form. Proper organization of these data and digital compilation of future data sets will increase the effectiveness of District decision-making procedures by providing instant access to all available information.

Because of the effectiveness of the GIS/RDBMS, it is recommended that the New York District use this technique to address future data collection and analysis requirements. As mentioned in the data descriptions, some customized programming was required to reformat the data for loading into the GIS/RDBMS. Similar programming needs will exist for future uses as well. These services should be addressed in the project planning and budgeting process for effective project implementation. In addition, future data capture efforts should consider requirements of the GIS/RDBMS before execution. Attention should be given to issues such as accurate coordinates and data file formats. Pre-planning in these matters can save considerable processing time when loading data into the GIS/RDBMS.

Hardware and software maintenance are imperative for efficient system operation and should be addressed in the project planning and budgeting process. The estimated cost for system maintenance is $10K per year. Maintenance is an expensive but indispensable service. This service includes software upgrades to take advantage of ongoing improvements,

repair or replacement of hardware if problems occur, and technical support in use of the hardware and software. This will ensure the most efficient and productive use of the New York Bight GIS/RDBMS. Personnel training and system administration also are priorities for efficient use of the system. It is estimated that these services will cost between $30K and $50K per year.

References

Bocuniewicz, H., Goldsmith, V., Clarke, K., and Hansen, W. (1991). "New York Bight Geographic Information System: Development, results, and future efforts," RESSAL Report no. 91/1, Department of Geology and Geography, Hunter College, City University of New York.

Byrnes, M. R., and Hiland, M. W. "Shoreline position and nearshore bathymetric change," Chapter 3 in *Kings Bay Coastal and Estuarine Physical Monitoring and Evaluation Program: Coastal studies, Volume 1: Main text and Appendix A*; N. C. Kraus, L. T. Gorman, and J. Pope (ed.), in preparation, U.S. Army Engineer Waterways Experiment Station, Vicksburg.

Hansen, W. J., Goldsmith, V., Clarke, K. C., and Bocuniewicz, H. (1992). "A marine GIS examines dredging and wetland operations in the New York Bight," *GeoInfo Systems* 2(4).

Hecht, L. G. (1991). "Monitoring the Chesapeake Bay in real time," *GIS World*, Fort Collins, CO, 88-93.

Intergraph Corporation. (1991). *MGE/SX Reference Manual*. Huntsville, AL.

Ripple, W. (ed.) (1986). *Geographic Information Systems for Resource Management*. American Congress on Surveying and Mapping, Bethesda, MD.

Siderelis, K. C. (1991). "Land resource information systems." *Geographical Information Systems: Principles and applications*. D. J. Maguire, M. F. Goodchild, and D. W. Rhind (eds.), Longman Scientific and Technical, Essex, England.

Tomlin, C. D. (1990). *Geographic Information Systems and cartographic modeling*. Prentice-Hall, Inc., Englewood Cliffs, NJ.

Townshend, J. R. G. (1991). "Environmental databases and GIS." *Geographical Information Systems: Principles and applications*. D. J. Maguire, M. F. Goodchild, and D. W. Rhind (eds.), Longman Scientific and Technical, Essex, England.

Appendix A New York Bight GIS/RDBMS: User Training Guide

Introduction

This document was prepared as part of an introductory training course for Intergraph workstation-based mapping and geographic information system (GIS) hardware and software, as well as a reference for future project applications. It includes all topics covered in the training course, complete with illustrations and diagrams. The basic functions needed to complete a sample project are discussed in detail, and corresponding Intergraph user manuals are referenced. Portions of the contents of this document were summarized and compiled from Intergraph documentation and Byrnes and Hiland (in preparation).

The primary purpose of project-oriented training is to introduce potential users to the application of GIS/relational database management system (RDBMS) technology for use with marine and coastal data sets associated with the New York Bight study. Because this includes computer hardware and software modules, three primary topics will be stressed, as outlined in Table A1. First, **Introduction and Basic Operations** includes a review of Unix-based workstation operations, a brief discussion of MicroStation features and operations, and an introduction to Intergraph's GIS software, Modular GIS Environment (MGE). Second, the **Operation of MGE** will be covered in detail, including integration with other software applications used in the development of the New York Bight marine GIS, such as coordinate system operations, surface modeling software, database and graphical queries, and spatial analysis. Third, **Execution of Sample Project** will give participants hands-on experience with the use of GIS hardware and software using data collected from the New York Bight to address potential planning alternatives associated with a hypothetical offshore dredged material placement site. This training document provides details related to each component of the course.

Table A1
Course Outline for Project-Oriented Training

Introduction and Basic Operations

Basic workstation operations

- Login, logout, workstation user
- Shell, local window, terminal, tools
- Window movement, collapse, virtual screens, console
- Starting MGE and/or MicroStation

Review of basic MicroStation operations

- Panel menus, pull-down menus
- Levels: active level, turning on and off
- Views: turning on and off, moving, resizing, tiling, view attributes
- View scale and orientation: zoom in/out, window area, window center, pan, king's move, fit active, fit all
- Working units
- Reference files: attaching, detaching, display on/off, levels on/off
- Retrieving files

MGE concepts (see Chapter 3 in main text)

- Software organization: MicroStation, MGE_SX, RIS, Oracle, Applications
- Review of software packages and their purposes
- MGE organizational structure: projects, directories, files
- MGE data structures: categories, features, attribute tables, graphics
- Data included in NY Bight project

Operation of MGE

Explanation of all buttons on MGE Project Manager form:

- Applications: batch or non-graphic processes associated with different software modules
- GeoIndex Locate: overview of displayed views on a vicinity map
- GeoDatabase Locate: find graphics by selecting attributes or find database records by selecting graphics
- Select Map: open a design file
- Create: create a new project
- Copy: copy a project to a new one
- Modify: modify project information
- Setup: define categories, features, database relations, other project data structure and organization
- Delete: remove a project or files within a project
- Utilities: project and system management functions

Coordinate system operations and Project Manager

- Importance of a common coordinate system
- Coordinate system definition: primary coordinate system, secondary coordinate system, primary to secondary coordinate system transformation
- Seed files
- Mapping working units
- Coordinate system readout: primary/secondary longitude-latitude, primary/secondary easting-northing
- Precision keyin and "li="
- Map conversions
- Geodetic calculator
- Grid generation

(Continued)

Table A1 (Concluded)

Entering graphics and displaying features

- Select Map
- GeoDatabase Locate: provides access to database by querying graphics and access to graphics by querying database
- Design File Display: retrieve or attach other design files
- Change Map: retrieve a design file by clicking on a displayed reference file element

Displaying grid files, surface models, and imagery

- MGE Grid Analyst (MGGA)
  - Grid display manager, fit grid
  - Examine grid cell, display grid on/off
  - Create legend
- MGE Terrain Modeler (MTM)
  - Load from *.ttn*
  - Display parameters, display triangles
  - Load from *.grd*
  - Display parameters, display grid surface
  - Load from *.xyz*, convert *.xyz* to TIN model
  - Convert TIN to grid model, probe model
  - Iso display, manipulate view orientation

Execution of Sample Project

Create surface models from ship observation data

- Use Structured Query Language (SQL) Plus to extract ASCII files of latitude, longitude, and value for salinity and temperature
- Use *dat2mst* to load data ponts into a design file
- Draw data boundary, project onto model, and load as edge
- Display model, define display parameters, create legend

Create surface models from model output data

- Load models from *.xyz* files
- Convert *.xyz* to TIN model
- Load existing data boundary as edge
- Display model, define display parameters, create legend

Compute differences between ship observation data and model output data

- Load existing models
- Subtract surfaces using compute volume in Modeler
- Display model, define display parameters, create legend

Use MGGA to investigate siting of a dredged material disposal site

- Define criteria in terms of bathymetry and dissolved oxygen
- Load bathymetry and dissolved oxygen grid files
- Display grid files, create legends, examine relationships
- Overlay grid files
- Display resultant file, define display parameters, create legend
- Identify best potential disposal areas

Document conventions

This section describes conventions used in this document to portray the user's interaction with the hardware and software.

- Directory names are in bold type (e.g., **/usr/mgeprj**).

- File names are in *italic* type (e.g., *work.dgn*).

- Messages generated by the software provide information, whereas system prompts require input from the user. System prompts, messages, and menu selection options are in **`Courier bold`**. For example, when turning off reference file levels, the system will prompt **`RF Levels>`**, and the user may respond by keying in **`1-30`**.

- Text keyed in by the user is in `Courier`.

- Default values in a system prompt are enclosed in brackets ([ ]).

- Lowercase letters in a system prompt or message represent a name or value that varies. A lowercase **`x`** represents an alphabetic character, while a lowercase **`n`** represents a numeric character.

- Letters enclosed in angle brackets (< >) are used to indicate a specific key or button. For example, `<Return>` represents the RETURN or ENTER key and `<Ctrl>` represents the CONTROL key. `<Ctrl/z>` means to press the CONTROL key and z simultaneously.

Terminology

Some basic terms used throughout the user training guide are described below. These are summarized from the "MGE_SX Reference Manual, Volume I" (Intergraph Corporation 1992c).

- *Terminal window*, *VT window*, *VT220 window*, *local window*, and *shell* all refer to a non-graphic Unix command window.

- *Pointer* refers to the 3-button mouse or the 12-button cursor. *Screen cursor* refers to a symbol on the display that tracks the movement of the pointer.

- There are four basic functions of the pointer, each assigned to a specific button. These functions are:

  1 - Command button (<C>). The Command button communicates commands to the software, and it is used mostly with the 12-button cursor on a tablet menu. However, it is also used to initiate pop-up menus.

  2 - Data button (<D>). The Data button is the most commonly used button. It sends positional information to the software during digitizing, identifies views or elements on which to perform manipulations, and selects commands from on-screen menus.

3 - Reset/Reject button (<R>). The Reset button interrupts a process or rejects a selected function.

4 - Tentative button (<T>). The Tentative button snaps to a discrete position to allow precise input of positional information. On the 3-button mouse, a Tentative is performed by tapping the Data button twice in quick succession.

Figure A1 illustrates the button layout on the 3-button mouse and the 12-button cursor.

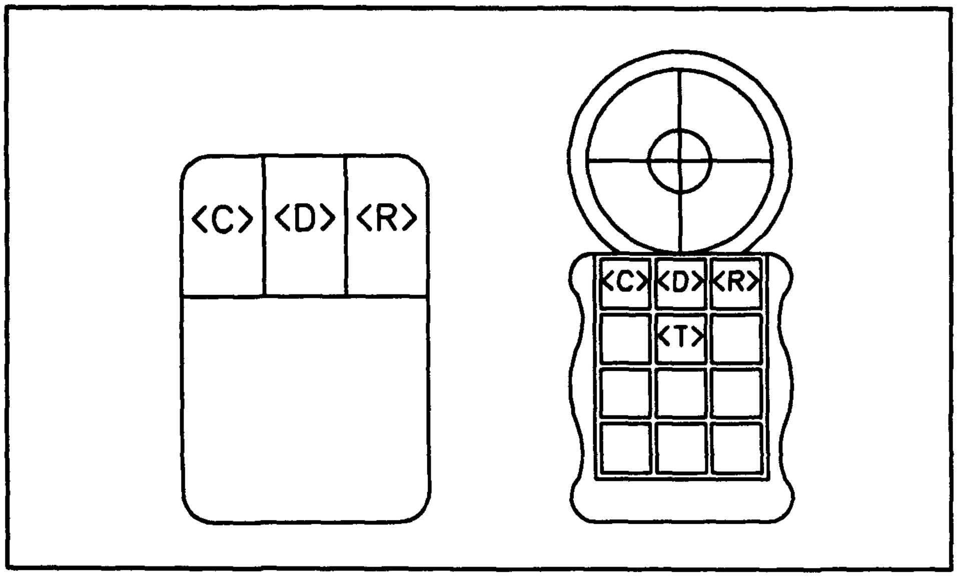

Figure A1. Illustration of a 3-button mouse and a 12-button cursor

- *Tap* means to press and immediately release a pointer button.
- *Press and hold* means to press and hold down a pointer button for the duration of the action performed.
- *Digitize* means to place the pointer at the appropriate location on the screen or digitizing tablet and draw elements by tapping <D>.
- *Select* means to tap <D> on a form button, field, menu button, or an item in a list.
- *Identify* means to locate an element on the screen either by tapping <D> or by keying in the name.
- *Accept* means to tap <D> to confirm or approve an action or information on a form. *Accept* also means to tap <D> anywhere in a view to accept a highlighted graphic element.

- An *icon* is a small symbol that represents an object or process. When an icon is selected, its represented object or process is activated.

Workstation Operation

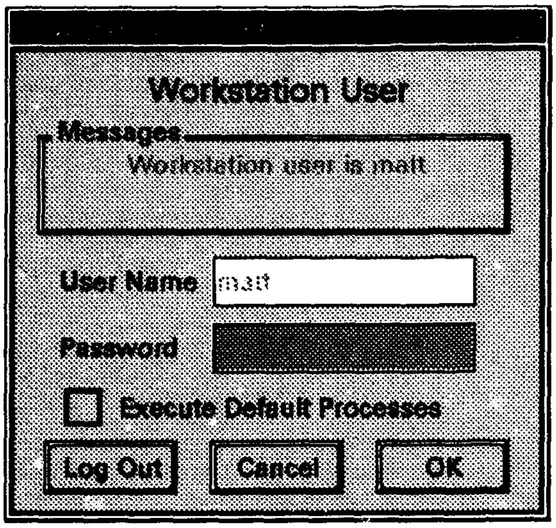

Figure A2. Workstation user menu

This section describes the basic skills needed to operate the workstation and access the GIS/RDBMS software. When the workstation initially starts up, or boots, the Workstation User menu appears (Figure A2). A valid user/name and password must be entered before the screen interface will run. All processes running on the system will execute under the privileges established by the workstation user. The Workstation User menu provides an initial level of security against unauthorized use by restricting access to command windows. When a user leaves the workstation, he/she should log out of the Workstation User menu as well as logging out of the command window. For further information on the workstation user, see Chapter 3 of the *CLIPPER System User's Guide* (Intergraph Corporation 1992a).

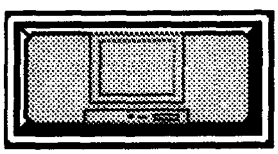
Figure A3. Workstation icon

After logging in as the workstation user, the workstation icon will appear in the lower left corner of the screen (Figure A3). Selecting this icon displays the workstation menu. From this menu, the user can log in as the workstation user, open local windows for access to the operating system, create terminal windows for access to other systems on the network, run processes, and modify the workstation menu.

When the workstation menu is displayed, the user selects a command by tapping a <D> on the command name. The following options are available:

Wkst. User accesses the workstation user menu to change the workstation user or log out from the workstation user.

Local creates a local VT220 window, which displays a prompt for a login and password. This allows a user other than the workstation user to run processes with his/her own privileges. It is important to remember that, unless a multi-user Unix license has been purchased, systems are limited to the workstation user plus two simultaneous users. Therefore, the person logged in as the Workstation User should use the *shell* option to open new windows, rather than *local*. This will allow simultaneous access to more users, which can be crucial in a networked environment.

Shell creates a local VT220 window and logs in as the current workstation user. However, this does not take up an additional login license. When logging out of a shell, the window is automatically deleted.

Console creates the console window that displays operating system messages; it is automatically created when the workstation boots up. A console window must exist for most processes to run properly, and more than one cannot exist simultaneously. Therefore, this option is rarely selected.

Terminal creates a command window connected to another system running the same operating system. The host name and other parameters are set in a menu that pops up when this option is selected.

Reboot activates the program that automatically stops and restarts the workstation.

Shutdown activates the program that executes procedures for a safe and orderly shutdown prior to powering off the workstation. It is important to wait for the **System halted...** message before turning off the workstation, as data loss may occur otherwise.

Configure accesses a menu that is used to configure the workstation menu. Options include adding commands to, or removing commands from the workstation menu, changing the screen background, and changing the number of virtual screens.

MSplot is an option that is added to the workstation menu when loading MicroStation. It is a utility for sending plot files created in MicroStation to a plotter or printer connected to the workstation.

Other utility options are available to be added to the workstation menu if the TOOLBOX product is loaded. These include a calculator, a clock, and software to play music on a Compact Disc-Read Only Memory (CD-ROM). For more information on these utilities, see Chapter 9 of the "CLIPPER System User's Guide" (Intergraph Corporation 1992a).

Window Operations

A typical command window is shown in Figure A4. Windows have three main components. The *working area* is the main part of the window where commands are entered and messages or output are displayed. The horizontal bar across the top is the *icon strip*. This contains icons that perform various window manipulation functions. The vertical bar on the right side is the *scroll bar*. This allows the user to review previously displayed text.

Figure A4. Typical command window

Several windows may be open at once, but only one window can be active at any time. To activate a window, position the cursor in the window's working area and tap <D>. The icon strip will be highlighted, and the window will then receive input from the keyboard. The icon at the upper left side of the icon strip is the delete icon. It is the only icon on the left side of the icon strip, and when selected, will delete the window. Usually, any processes running in a window will be killed when the window is deleted. Just to the right of the delete icon is a string of text that represents the name of the window. By default, this is the process ID of the window. For information on changing the text displayed at this position, see section 3.8 of the *CLIPPER System User's Guide* (Intergraph Corporation 1992a).

At the far right of the icon strip is the collapse icon. When this is selected, the window is reduced to a small rectangle showing only the delete icon, the window name, and the collapse icon. To restore the window, select the collapse icon once again. Immediately to the left of the collapse icon is the pop-to-bottom icon. When selected, this will move the window beneath all others displayed at the time. Immediately to the left of the pop-to-bottom icon is the pop-to-top icon. This will cause the window to be displayed on top of all others.

Immediately to the left of the pop-to-top icon is the modify icon. It is used to move or resize a window. When the modify icon is selected, a different screen cursor and a highlighted outline of the window are displayed. To move a window, position the modify cursor in the central area of the window, so that it displays arrows in four directions. Press and hold the <D> button while moving the pointer. The highlighted outline of the window will move accordingly, and when the <D> button is released, the outline will stop moving. If the new position is satisfactory, accept the move by tapping a <D>. To continue moving, press and hold the <D> button as before. Windows may also be moved by pressing and holding the <D> button while positioned on the very edge of the window, then dragging the highlighted outline to a new position. When <D> is released, the window will move to the new position.

To resize a window, select the modify icon as above. When the cursor is positioned along the outer edges of the window, it is displayed as two directional arrows, which may be oriented right-left, up-down, or diagonal, depending on position within the window. Press and hold the <D> button and move the cursor to resize the window. Once again, when the <D> button is released, the highlighted outline remains displayed. Accept the new size of the window by tapping a <D>.

When several windows are open simultaneously, the desired icon of a certain window may be covered by other windows. In this case, position the cursor anywhere in the icon strip, or at the edge of the window, and tap a <D>. This will pop up a small box containing all of the icons in the icon strip. All of the functions available in the icon strip are available and operate identically in the icon box.

Note that several other icons are displayed to the left of the modify icon. These are not critical to this introductory text and will not be covered. However, they are often quite useful and are discussed in detail in section 3.5 of the *CLIPPER System User's Guide* (Intergraph Corporation 1992a).

Basic UNIX Commands

Because the focus of this course is on the GIS/RDBMS, and because the GIS/RDBMS is driven by a user-friendly graphical user interface, little time will be spent on UNIX. However, some basic concepts and commands are used frequently enough to warrant a brief description.

UNIX has a hierarchical file structure, with the root (/) directory at the top (Figure A5). The **/usr** directory is a subdirectory under root, and user login directories and data files are usually in subdirectories under **/usr**. When a user logs in to the system, he/she is automatically placed into a home directory, which is usually named **/usr/username**, where **username** is replaced with the user's login ID. When a user login is

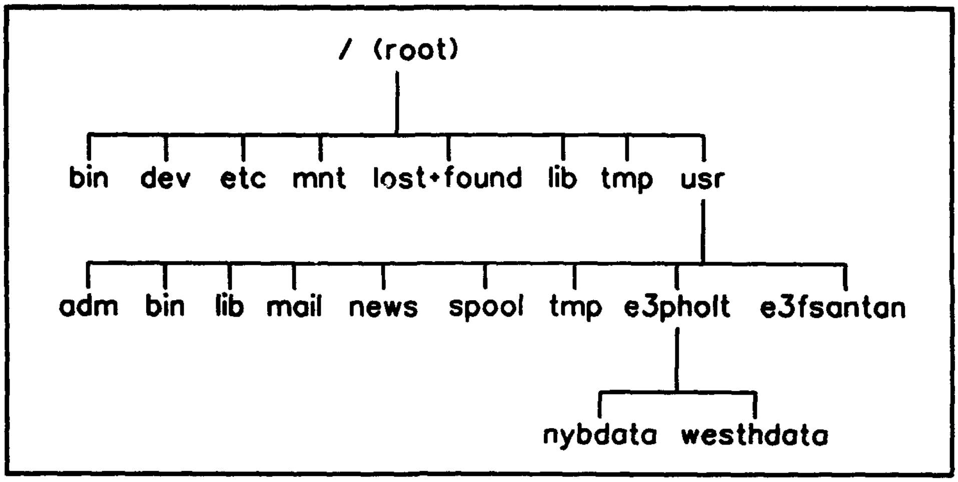

Figure A5. A hierarchical UNIX file structure (actual directory names will vary)

created, certain files are placed in the home directory that control certain aspects of their environment. The most important of these are the *.profile* and *.env* files. The system administrator should set up these files initially so that all users can access and execute the GIS/RDBMS software. However, specific directory components may need to be customized for individual users, such as default directories to place or look for data. A complete discussion of these files is beyond the scope of this course, but it is important to be aware of their existence and function. Further discussion of these files can be found in the *CLIPPER System User's Guide* (Intergraph Corporation 1992a).

The active directory is the directory that the user is currently occupying. In other words, when a command is issued that involves searching for files, it usually looks in the active directory. To see a listing of the files in the active directory, key in `ls` . This will list all files in the active directory. When a user is occupying the home directory, notice that the *.profile* and *.env* files mentioned above are not shown. Files beginning with a "." are hidden files and can be seen by keying in `ls -a` . To see more information about the files, key in `ls -l` . This returns a listing in the following format:

```
-rw-rw-rw-   1 matt   users       297 Jun 26 09:19 cvt_error_log
-rwxrwxrwx   1 matt   users      9216 Jun  3 04:21 kbslide.dgn
-rw-rw-rw-   1 matt   users      4447 Jun  3 10:51 mi.par
drwxrwxr-x   2 matt   users       576 Jul  4 10:12 oldnybdata
-rw-rw-r--   1 matt   users      6512 Jul  4 10:18 ris.history
-rw-rw-r--   1 matt   users      2343 Jun  9 20:01 sal760908-14su
```

The first character in each line indicates whether the listing is a file or a directory. The next three characters indicate the privileges for the owner of the file, where **r** stands for read, **w** stands for write, and **x** stands for execute. The next three characters represent privileges for other members of the same group of users, and the final group of three

characters indicates privileges for all other users. The next column indicates the number of links, the final five columns contain the login name of the owner of the file, the group name, the size of the file in bytes, the date and time of the last modification to the file, and the file name.

To move to another directory, use the command `cd`. By keying in `cd ..`, the user will move one level up in the hierarchy. To change to a subdirectory under the active directory, key in `cd directory name`. To change to a directory under a different branch of the hierarchy, the user must key in the entire pathname. For example, to change from **/usr/joe/subdir1/subdir2**, and you wish to change to **/usr/ip32**, key in `cd /usr/ip32`.

Processes in the GIS/RDBMS can create very large data files. Therefore, it is often necessary to see the amount of space available on the disk. Key in `Free`, and the system will return a listing similar to this:

```
File System   Device      Free +    Used = Total Blocks  % Used

/             s0u0p7.0    8311 +   16689 =    25000        67%
/usr          s0u0p7.3  765803 + 1161897 =  1927700        61%
/usr2         s3u0p7.4  637381 +  359619 =   997000        37%
```

The amounts Free, Used, and Total Blocks are given in 512-KB blocks.

Occasionally, a user may start a process accidentally, or realize that a wrong parameter was entered, and desire to stop the process. By keying in `ps -fe`, all processes currently running on the workstation will be displayed in this format:

```
UID  PID PPID C    STIME TTY      TIME COMMAND
root   0    0 0 14:02:05 ?        0:00 sched
root   1    0 0 14:02:05 ?        0:02 /etc/init
root   2    0 0 14:02:05 ?        0:00 vhand
root   3    0 0 14:02:05 ?        0:00 bdflush
root   4    0 0 14:02:05 ?        0:00 loadd
root   5    0 0 14:02:05 ?        0:00 fontd
root 374    1 0 14:43:52 console  0:00 /etc/getty console
root  58    1 0 14:02:19 tty02    0:00 /etc/getty tty02 9600
matt 278  234 0 14:05:07 ?        0:15 vterm -T Krusty Window
lp   231 1    0 14:02:55 ?        0:00 /usr/lib/lpsched
matt 279  278 0 14:05:08 ttx00    0:00 /bin/ksh
matt 286  279 0 14:11:42 ttx00    2:35 iedit -w trainman.txt
```

The first column indicates the user running the process and the second column shows the Process ID number. To kill a process, type in `kill n`, where `n` is the Process ID number. The user can only kill processes that have been assigned to him under the User ID in the first column. However, when logged in as the workstation user, it is possible to kill a process that has your User ID, but that you did not initiate; therefore, care must be taken. Details on many other useful and powerful features of the

operating system are given in Chapter 4 of the *CLIPPER System User's Guide* (Intergraph Corporation 1992a).

Review of MicroStation Operations

MicroStation is a full-function Computer-Aided Drafting and Design (CADD) and graphics software package. Although it is rather complex, the intuitive graphical user interface allows novice users to quickly become productive users. There are a few basic concepts and methods that must be learned before moving on to more advanced operations, and these basics will be covered in this section.

MicroStation forms the graphical base on which Intergraph GIS applications are built. Many of the GIS applications can be run independently of each other, but they all require MicroStation. Therefore, there are many ways to start MicroStation. Because this course focuses on the GIS/RDBMS applications, MicroStation will be accessed through the MGE_SX project manager.

MicroStation files

MicroStation data files are referred to as design files. Design files are either two-dimensional (2-D) or three-dimensional (3-D). They are binary files with a default extension of *.dgn*. (The file format is described in full in the MicroStation Development Language documentation.) Any extension may be used, though applications built on MicroStation occasionally assume a *.dgn* extension, and files may not be accessible by certain processes if they are named differently. Any time a file name is keyed in without an extension, MicroStation will assume a *.dgn* extension. If design files with other extensions are used, the full file name with its extension must be keyed in.

All design files are divided into a finite number of positions. Each of these positions is a unit of resolution (UOR). There are 2^{32} X 2^{32} UORs in a 2-D design plane, and 2^{32} X 2^{32} X 2^{32} UORs in a 3-D design cube. Working units are groups of UORs that allow positions to be recorded in real world units. Working units are divided into master units, subunits, and positional units. One positional unit is always equal to one UOR, and these terms are often used interchangeably. If the master units are set to feet, subunits are set to 12 in./ft, and 1,000 positional units/in., points can then be placed to a precision of 1/1000th in. Using this precision, a 1.28- by 10^{11}-ft^2 (4,590-sq mile) area (2^{32}/12/1000 X 2^{32}/12/1000) can be represented. To place points to 1-ft precision, the subunits and positional units should be set to one. This would give a 1.85- by 10^{19}-ft^2 area (2^{32} X 2^{32}). For the New York Bight Study, the master units are meters, with 1,000 subunits per master unit, and one positional unit per subunit. This means that

the mappable area of each design file is 1.845 m^2 by 10^{13} m^2 ($2^{32}/1000$ X $2^{32}/1000$), and points can be placed to 1-mm precision.

The global origin is the point on the design plane with UOR coordinates of 0,0. By default, it is at the center of the design plane, with an equal number of positive and negative integers in the x and y directions. The global origin can be changed, though the total number of possible positions (UORs) does not change. For example, if the global origin is placed at the lower left of the design plane, larger positive coordinate numbers can be used, but no negative numbers.

MicroStation creates new files by copying seed files, or empty design files. Several seed files with different parameter settings are delivered with the software and are located in **/usr/ip32/mstation/seed**. Seed files will be discussed in more detail in a later section.

Starting MGE_SX and MicroStation

To bring up the MGE_SX Project Manager form, key in mge at the UNIX prompt. Select an active project by tapping a <D> on the project name, and then tap a <D> on the Select Map button. Select the file name *train.dgn*. The Project Manager form will be dismissed, and MicroStation will display the selected file.

MicroStation menus

Figure A6 shows a typical screen arrangement when operating Microstation through MGE. The strip of icons across the top of the screen is the bar menu. The gray strip along the right side of the screen is the panel menu. The icons at the top of the panel menu represent all of the applications currently available on the workstation. The MicroStation Command window is at the bottom of the screen. It provides communication from the keyboard to the software, displays prompts when the software needs input, displays status messages, and contains pull-down menus for access to MicroStation commands. The vertical rectangular menu along the left of the screen is an example of a palette menu, which is activated from the MicroStation Command Window. Each button on the palette menu produces another menu of related commands. These menus can be "torn off" from the palette menu for easier access to the commands. The central area of the screen contains a MicroStation view, where graphics are displayed. All menus, as well as the MicroStation command window, can be moved. The bar and panel menus can be resized, but the results are not necessarily favorable.

All MicroStation commands can be accessed through the panel menu or the menus on the MicroStation command window. In addition, many of the commands have key-ins, and some of the more frequently used commands are located in the bar menu. To select a command from the bar

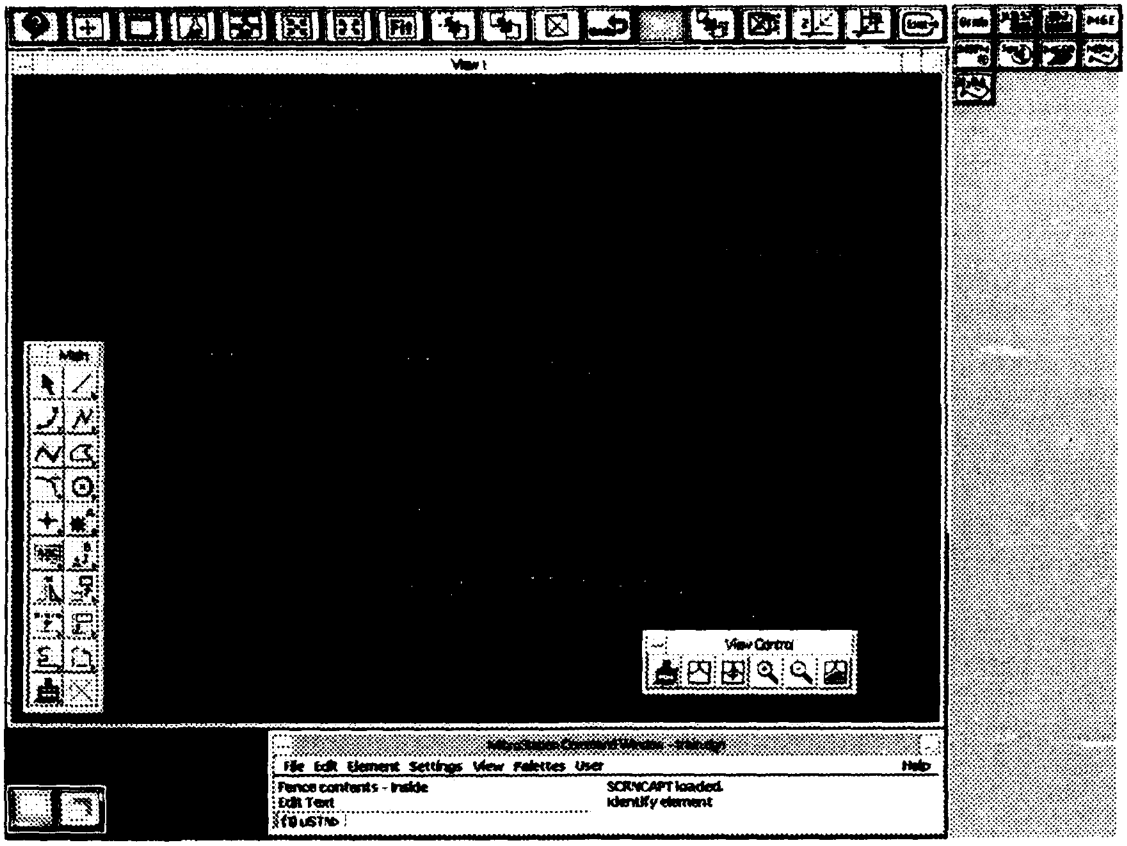

Figure A6. A typical MicroStation view and menu arrangement

menu, position the screen cursor over the menu button, and tap a <D>. A message will appear in the MicroStation command window identifying the command selected. To select a MicroStation command from the panel menu, tap a <D> on the MicroStation button. A submenu will appear, with each button representing a related group of commands. Upon selection of one of these buttons, another submenu will appear, containing commands or additional menu buttons, depending on the one chosen.

To use the pull-down menus on the MicroStation Command Window, place the screen cursor over one of these words:

File Edit Element Settings View Palettes User

Press and hold a <D> and the menu will appear. Continue to hold the <D> and move the cursor over the desired command. When you release the <D>, the command will be activated. Some of the selections produce other menus, while some activate a specific command. The selections under the **Palettes** menu produce additional menus, with groupings of related commands. Some of the selections under **Palettes** have an arrow pointing to the right. While continuing to hold the <D>, position the cursor over one of these, and move the cursor to the right. A secondary

menu will pop up. These options may be selected by positioning the cursor and releasing the <D>.

Design file levels

Each MicroStation design file contains 63 levels. At any time, one level is specified as the active level. When elements are placed in the design file, they are placed on the active level. The active level is always displayed, though any of the other levels can be on or off. To determine which levels are currently displayed, press and hold a <D> on the `View` menu of the MicroStation command window. Move the cursor over the `Levels` selection and release the <D>. A menu will appear that displays a `View Number` indication at the top, and a listing of numbers 1-63 (Figure A7). A black circle is displayed to indicate the active level, and black squares indicate levels currently displayed. Tap a <D> on the level number to toggle the display on and off. After selecting the proper levels to be displayed, select the `Apply` button to update the view. This menu can also be activated by keying in <Ctrl/E>. Levels may also be turned on and off by keying in `on=n` to turn a level on, or `of=n` to turn a level off, where `n` is the level number.

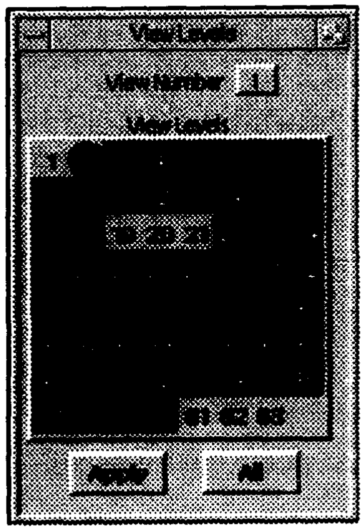

Figure A7. The level manipulation menu

To change the active level, key in `lv=n` , where `n` is the level number, or double-click <D> on the desired level number on the view levels menu. Alternately, the active level can be changed through the `Element Attributes` menu. To activate this menu, press and hold <D> on the `Element` selection in the MicroStation Command Window, move the cursor up to `Attributes` , and release the <D>.

Design file views

Up to eight views can be displayed at one time, each with different level and display configurations. The number or name of the view is given in the gray strip across the top of the view. To move a view, place the screen cursor in the gray strip at the top of the view. A four-directional arrow cursor appears. Press and hold the <D> and move the cursor. A highlighted outline of the view moves with the cursor. When the <D> is released, the view moves to the new position. To resize a view, move the cursor to the edge of the view. A two-directional arrow cursor appears, with the directions displayed indicating the direction of modification

enabled. Press and hold the <D> and move the cursor. A highlighted outline of the view appears and moves with the cursor. When the <D> is released, the view is resized. If one view is displayed on top of another, the one below can be moved to the front simply by tapping <D> on the gray bar. A view can be lowered, collapsed, or restored using the small horizontal bar icon in the upper left corner of the view. Press and hold the <D> on this icon to produce a list of options. The **Close** option turns off the view. The view can also be turned off by double clicking on the icon. The **Lower** option moves the view behind all other views and windows displayed. The **Minimize** option collapses the view to its smallest size. **Minimize** is also accomplished by tapping a <D> on the small dot icon near the upper right corner of the view. The **Maximize** option expands the view to its largest size. **Maximize** is also accomplished by tapping a <D> on the small square icon in the upper right corner of the view. Restore returns the view to its previous size.

Views that have been turned off can be restored by keying in `view toggle n`, where `n` is the number of the view. This command also will turn off views that are currently on. In addition, views can be turned on and off using the **Open/Close** option under the **View** menu on the MicroStation command window. The **Tile** option resizes all current views to identical sizes, and arranges them evenly on the screen. If only one view is on, this has the same effect as the **Maximize** command. The **Attributes** option under the **View** menu displays a menu through which various aspects of the display are controlled. Details of the functions of each are given in the MicroStation reference guide.

View scale and orientation

Several commands are available in MicroStation for adjusting the scale, orientation, and area of coverage of views. The View Control menu is pictured in Figure A8. This is accessed through the main palette menu. The commands, in order from left to right, are **Update View, Window Area, Window Center, Zoom In, Zoom Out, and Fit Active**.

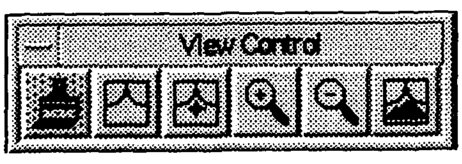

Figure A8. The MicroStation View Control menu

Update View redraws the display of a view. This is sometimes necessary when level display or view attribute changes have been made. Tap a <D> on the menu button, and then tap a <D> in the view to be updated. **Window Area** is one method of enlarging a particular area of a display. After selecting the command, draw a box on a view depicting the area desired. Then, tap a <D> in the view in which to display the selected area. **Window Center** keeps the same scale of a view, but changes the area displayed. After

selecting the command, tap a <D> in a view indicating the point that will be moved to the center of the view. Then tap a <D> in the view to be changed.

Zoom In changes the scale and area of a view by making the displayed image larger, imitating moving the viewer closer to the elements. After selecting the command, tap a <D> in the view to be changed. The point indicated will become the center of the view, and the elements displayed will enlarge by a fixed percentage. **Zoom Out** changes the scale and area of a view by making the displayed image smaller. This operates in the same manner as **Zoom In**, only having the opposite effect.

Fit Active determines the areal extent of all elements on all levels currently displayed and displays them at the maximum size possible in the view selected. After selecting the command, tap a <D> in the view in which to display all elements. Similar commands are **Fit Reference** and **Fit All**. The **Fit Reference** command sets the view to the extent of the current reference file. The **Fit All** command sets the view to the extent of all reference files and the active file. Reference files are discussed in the following section.

The above commands can also be activated by keying in the command names. Also, the same commands are accessible in the bar menu, though the buttons have different symbols representing the same commands. Figure A9 shows the view control commands in the bar menu. They are, from left to right, **Window Center, Window Area, Update View, Update All Views, Zoom In, Zoom Out, and Fit Active**.

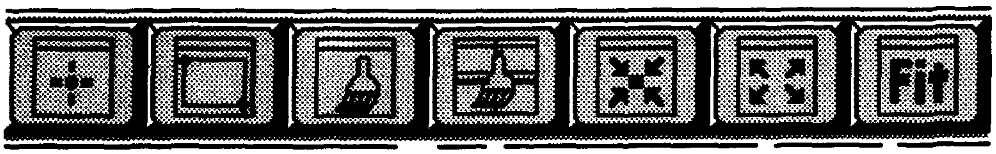

Figure A9. The view commands portion of the bar menu

A pan function is available by simultaneously depressing <shift> and pressing and holding <D> on the pointer. By moving the cursor, the view will adjust accordingly. A similar command can be found in the panel menu. Select the **MGE** button, then the **Design Files** button, then the **King's Move** button. A submenu of nine buttons then appears, with the **Update View** button in the center. By selecting one of the arrow buttons, and then selecting the desired view, the view will be moved by a preset percentage in the direction indicated.

Reference files

Reference files provide a means of simultaneously viewing data stored in multiple design files. The file called up by MicroStation is the active file. Elements can be placed into the active file and existing elements can be manipulated. Reference files are design files attached to the active file in such a manner that they can be viewed with full level control capabilities. However, elements in the reference file cannot be deleted or changed.

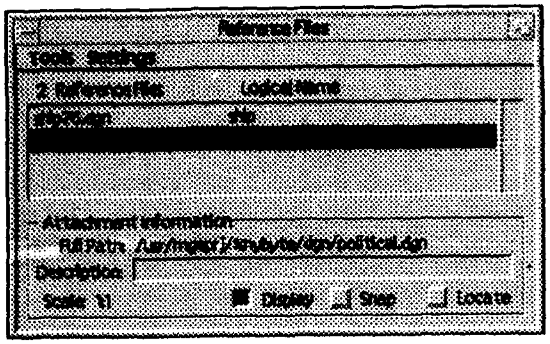

Figure A10. The Reference File menu

To activate the **Reference File** menu (Figure A10), press and hold a <D> on the **File** option in the MicroStation command window. Move the cursor to **Reference** , and release the <D>. All reference files currently attached are listed in the center portion of the menu. To attach a design file as a reference file, move the cursor over **Tools** near the upper left corner, press and hold a <D>, move the cursor to **Attach** , and release the <D>. The **Attach Reference File** menu will appear. It lists all design files available in the active directory, as well as providing a means for changing directories.

To review or change the settings for a particular reference file, tap a <D> on the reference file name. The three main settings are indicated by three buttons along the bottom of the menu. If a button is depressed, or darkened, the corresponding setting is on. The **Display** button indicates whether the selected reference file is currently displayed. The **Snap** function, when activated, allows tentative points to be placed on positions in the reference file. The **Locate** function allows limited access to the elements in the reference file. For example, an element can be copied from the reference file into the active file if the **Locate** function is on.

To turn reference file levels on and off, press and hold a <D> on **Settings** , then move the cursor to **Levels** and release the <D>. This will activate a menu similar in appearance and operation to the **View Levels** menu . To detach a reference file from the active file, first select the reference file to be detached. Then press and hold a <D> on **Tools** . Move the cursor to **Detach** and release the <D>. A menu will appear asking for verification of detaching the file. Tap a <D> on **OK** to detach, or **Cancel** to leave the file as is.

Usually, design files attached as reference files have the same working units and coordinate system definition as the active file. When this is the case, the two files overlay in their proper spatial relationship to each other. In some cases, however, files of different origins and working units

may be used in conjunction with each other. Reference files may be moved, scaled, and mirrored to accommodate these needs. The area displayed may also be restricted by various means. Descriptions of these functions are found in the MicroStation documentation.

Operation of MGE

This section describes the MGE Project Manager menu and briefly discusses all of its features and functions. To access the Project Manager menu, log in to the system, then key in `mge` . The title of the menu is in the upper left-hand corner, and the version of MGE_SX that is currently running is in the lower right-hand corner (Figure A11). In the upper right-hand corner are two buttons. The one labeled **`VT`** opens a VT window with the directory set to the active directory. The **`X`** button exits from the MGE Project Manager environment.

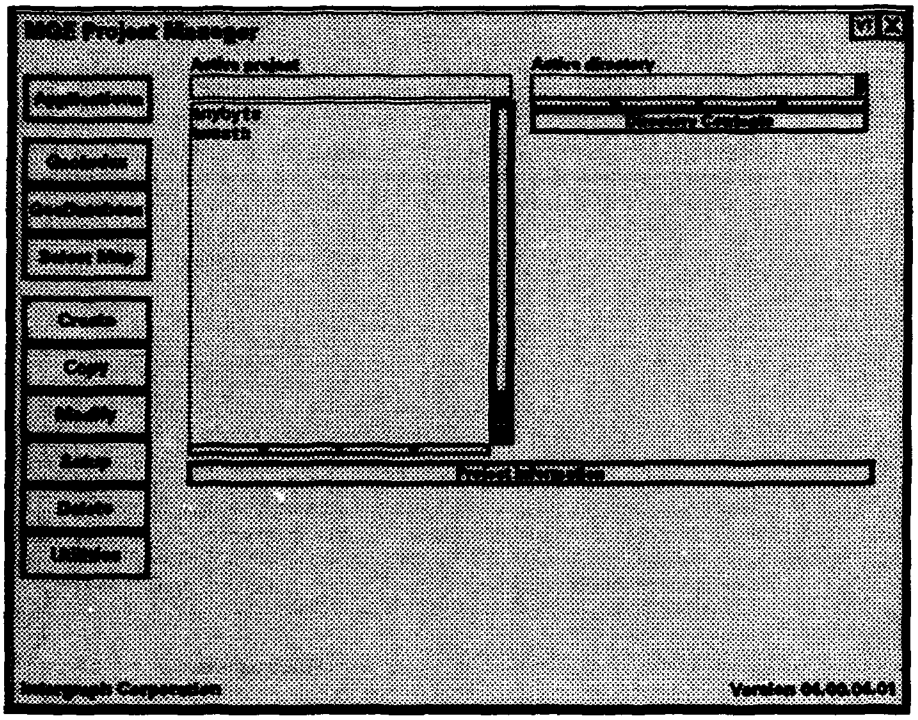

Figure A11. The MGE Project Manager menu

The single field under the **`Active project`** label indicates the active project. Only one project can be active at a time. The scrolling list field lists all MGE projects currently defined. A message at the bottom of the menu indicates the current state of the software. The initial message is **`Select project and/or option`** . Select an active project by placing the cursor over the project name and tapping a <D>. The project name is highlighted and placed into the **`Active project`** field . The

message at the bottom of the menu changes to **Processing...** while the software sets the appropriate active directory and other information specific to the project selected. After this is completed, the message returns to **Select project and/or option**.

To the right of the **Active project** label is the **Active directory** label. The directory under which all data for the active project are stored is displayed in the field directly below the **Active directory** label. Directly beneath this field is a button labeled **Directory Contents**. When this button is selected, all subdirectories and files under the active directory are displayed (Figure A12). Notice that the **Active directory** field has an associated list. Tap a <D> to get a listing of all directories under the active directory. To examine the contents of a particular directory under the active project, select the directory name from the list, and the directory contents field will be updated to include only data in that directory. The active directory affects the current directory for a VT window initiated from the menu and the directory from which maps are selected to enter graphics. Currently, the only way to return the active directory to its original value is to reselect the active project.

Under the active project and active directory fields is a long button labelled **Project Information**. Select this button to review information on the creation of the active project (Figure A12). Along the left-hand side of the menu are 10 buttons, each representing either a specific

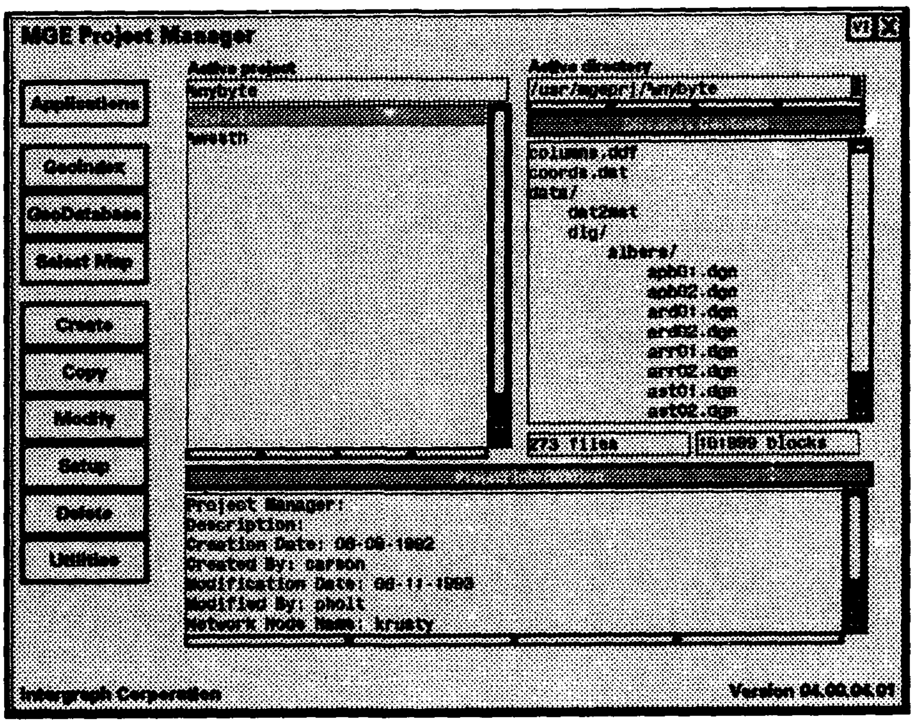

Figure A12. The MGE Project Manager menu, showing the active project, active directory, and project information

operation or a group of related operations. These are discussed in the following paragraphs as they occur in order from top to bottom.

The **Applications** button accesses a menu or series of menus that contain non-graphic software operations for all currently loaded software modules (Figure A13). The toggle switch in the lower left-hand corner of the Applications menu switches between listing non-graphic applications by software module and listing all available applications simultaneously. With the switch set to **Show by level**, select one of the module names. Another menu is displayed, with either a listing of groups of applications or a list of applications, depending on the module selected. In the lower right-hand corner of the menu, the **Previous level** button is activated. Select this button to return to the previous menu.

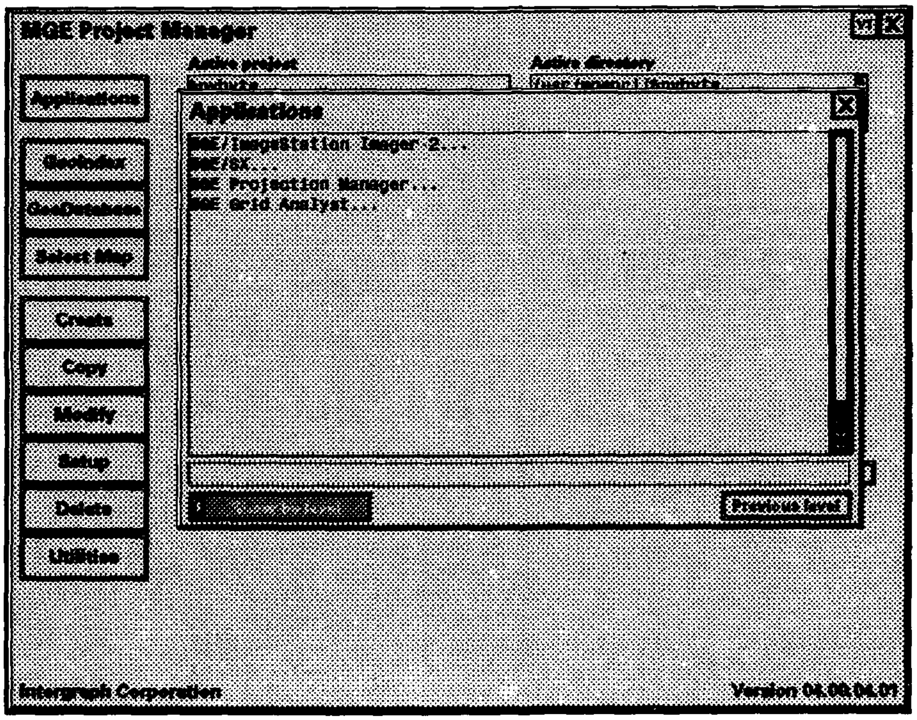

Figure A13. The Applications menu

The **GeoIndex** button enters the graphics environment by displaying a default file named *work.dgn* and activates the GeoIndex Locate function, which provides an overview of the spatial extent of views displayed on a vicinity map. The vicinity map is usually a general map of the entire study area. It is attached as a reference file and displayed in one view. The other views displayed are smaller portions of the study area. The area covered by each view is represented on the vicinity map by a box containing the number of the view.

The **GeoDatabase** button enters the graphics environment by displaying the *work.dgn* file, and activates GeoDatabase Locate. This is

one of the most useful aspects of MGE because it provides access to graphics by performing database searches and also provides access to the database by identifying graphics. These powerful operations are performed through a user-friendly graphic interface. GeoDatabase Locate will be covered in more detail in a later section.

`Select Map` activates a menu that lists all design files in the currently selected directory (Figure A14). The default is the **dgn** directory under the active project. The Select Map menu displays the directory from which files are listed. The **`Filter`** field provides a place to enter wild cards to limit the listing to file names containing certain strings. The **`Available files`** field lists all files in the displayed directory that match the filter designation. Any design file in the list can be displayed in graphics by tapping a <D> on the file name. At the bottom of the list is a key-in field. A file name can be keyed in here to display the file. If a filename that does not exist is keyed in, the Create Map menu is activated, providing a means for creating new files (Figure A15). To create a new file, select the seed file from the associated list, then select the checkmark button to create the new file and display it. To exit without creating a new file, select the **`X`** button.

The **`Create`** button accesses a menu for creating new projects (Figure A16). Certain information is automatically generated (e.g., Creation Date, Created By, Modification Date, Modified By, and Network Node Name). The other fields can be filled in by keying in information. The

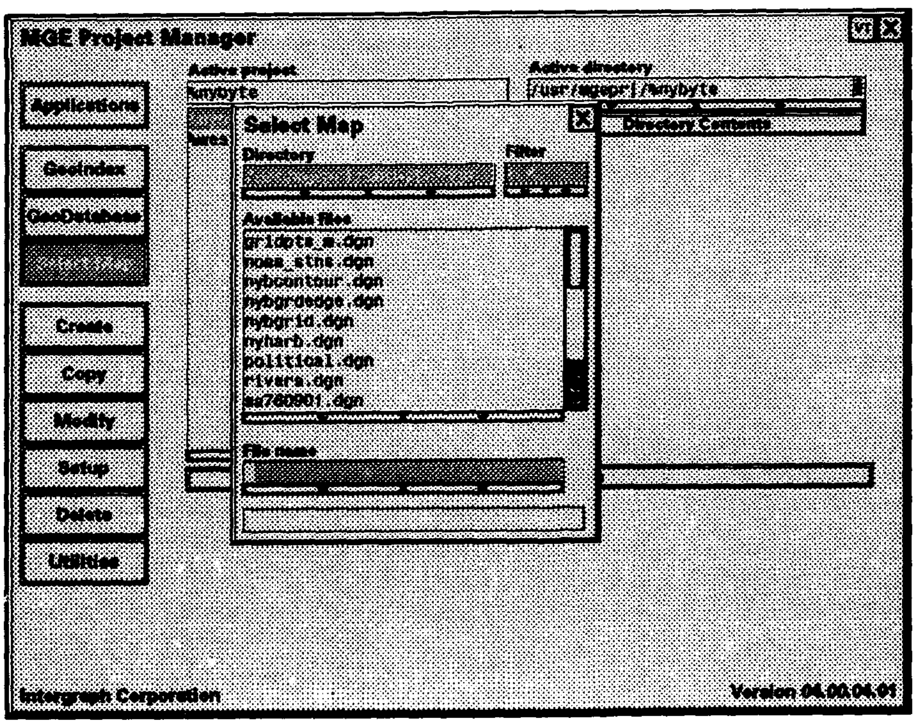

Figure A14. The Select Map menu

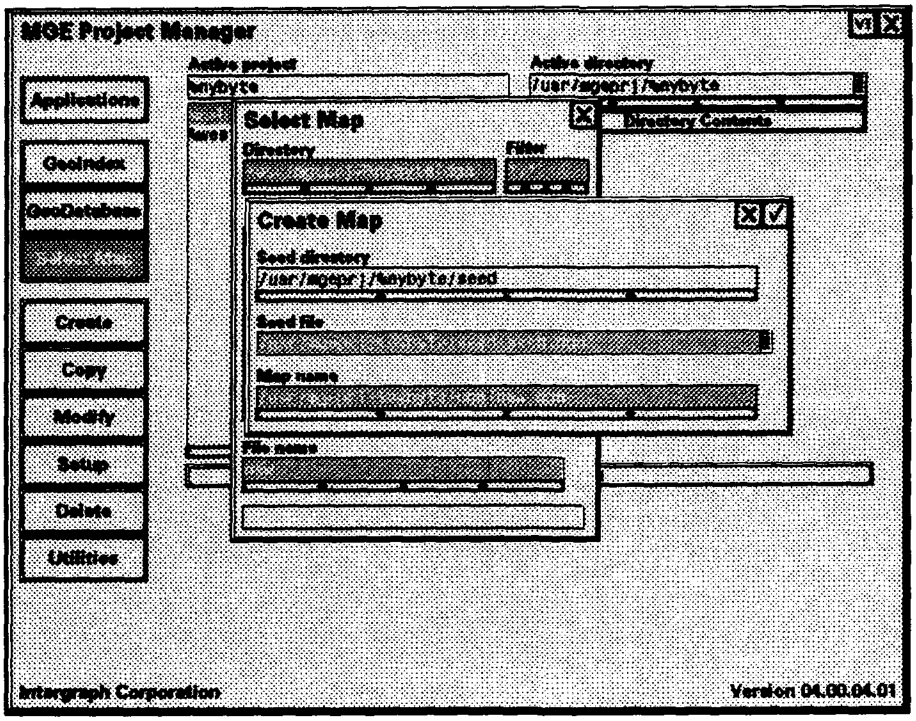

Figure A15. The Create Map menu

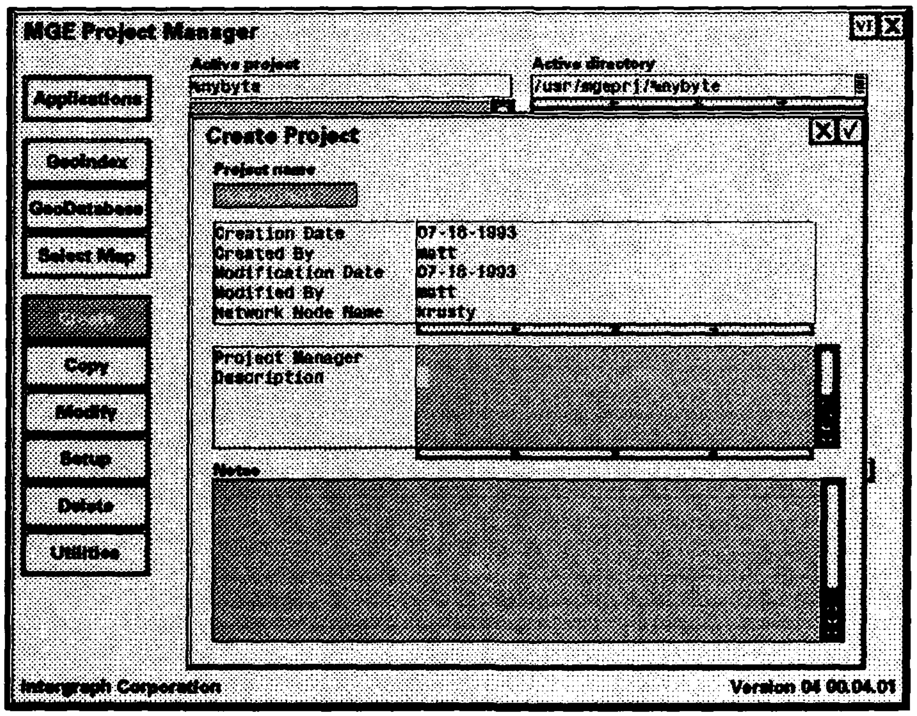

Figure A16. The Create Project menu

only field that is required is the **Project name** . The others are general information concerning the project. The information entered is displayed when the **Project Information** button is activated.

The **Copy** button activates the Copy Project menu. An entire project, or portions of the project, can be copied to create a new project. The **Modify** button activates the Modify Project menu, through which the Project Information fields are modified.

The **Setup** button activates the Project Setup menu, from which several very important functions are accessed (Figure A17). **Define Project Schema** selects the database schema that is to be associated with the current project. This usually is performed only once with each project. **Category Builder** defines the categories of data to be entered in the project. **Feature/Schema Builder** defines features of data to be entered in the project, as well as the attribute tables associated with them.

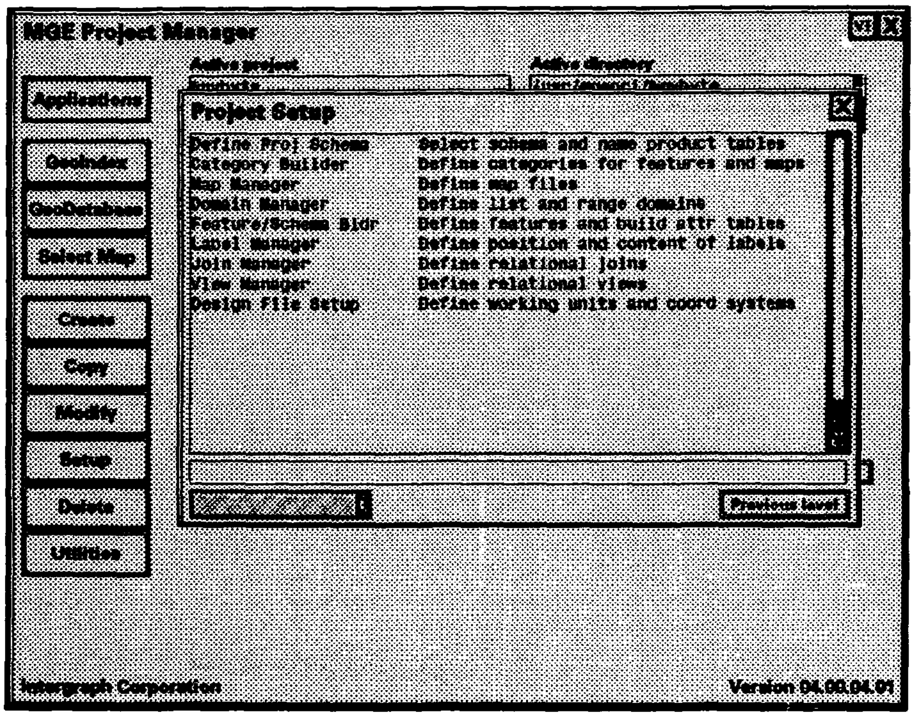

Figure A17. Project Setup menu

The **Delete** button accesses the Delete Project menu. An entire project, or certain files within a project, can be deleted from this menu. To exit the menu without deleting anything, select the **X** button. To delete the selected files, select the check-mark button.

The **Utilities** button accesses the Utilities menu, which contains functions that are general in nature. Except for the **Export Project** and **Import Project** , these can be executed without selecting an

active project. **Relational Interface System (RIS) Schema manager** displays all schemas available to MGE. Through this menu, RIS provides access to different databases on different machines and running different database management software. However, RIS interprets all of this information so that these operations are transparent to the user. A **Process List** is created automatically when MGE starts up. However, if the **Process List** is killed, a new one can be created from this menu. **Export Project** bundles an entire MGE project, including all graphics files, text files, data files, and database information, into one archive file that can be moved to another workstation. The **Import Project** reads this archive file and creates the project and database in the new location.

Coordinate Systems and Projection Manager

To accurately input, display, and analyze geographic data, it is necessary to bring all source data to a common system of positional reference. To do this, geodetic variables must be identified and evaluated for all geographic input data. The basic elements of horizontal positioning and the drawing of maps are the spheroid of reference (more recently called the ellipsoid), the geographic datum, and the map projection. Additional requirements exist for accurate comparison of vertical positions, but these are not discussed in this text.

Spheroid of reference

The spheroid of reference is a mathematical representation of the earth's surface or a specific portion of the earth's surface. Variables comprising the spheroid are distance measurements of the semi-major axis and semi-minor axis. Various spheroid calculations are often compared by their values of flattening. If a is the semi-major axis of the earth and b the semi-minor axis, then the flattening f is defined as $(a-b)/a$ (Snyder 1987). There have been many spheroid calculations, the most important of which are the Bessel spheroid of 1841, the Clarke spheroid of 1866, and the Geodetic Reference System 1980 (GRS 80) ellipsoid.

Geographic datums

A geographic datum, as defined by Shalowitz (1964), is

> ...the adopted position in latitude and longitude of a single point to which the charted features of a region are referred. More specifically, it consists of five quantities: the latitude and longitude of an initial point, the azimuth of a line from this point to another point to which it is tied by the triangulation, and two constants necessary to define the terrestrial spheroid. It forms the basis for the computation

of horizontal control surveys in which the curvature of the earth is considered.

All geographic positions are associated with a datum. If two locations are given in different datums, and no corrections are made to bring them to a common datum, then the spatial relationship between them will be in error. The terms geographic datum, geodetic datum, and datum are all used interchangeably.

Prior to 1899, there was not a triangulation network that covered the entire country. Instead, there were several detached systems of triangulation based on astronomic readings. Each of these systems represented an independent datum. With the completion of the transcontinental arc of triangulation, it was possible to unite these independent networks into a single datum for the entire country. This datum was named the United States Standard Datum, used the Clarke 1866 spheroid as its reference, and had its origin at station Meades Ranch in Kansas. In 1913, the network was expanded to include both Canada and Mexico and renamed the North American Datum. However, no changes in the definition of the datum, and therefore no changes in the coordinates of any points previously referenced to the datum, were made.

Between 1927 and 1932, the North American Datum 1927 (NAD 27) was developed from previously existing and newly added triangulation data (Bowie 1928). The reference ellipsoid was still Clarke 1866 with Meades Ranch as the origin. For the NAD 27 adjustment, latitude and longitude at Meades Ranch were held constant, while all other stations in the network changed positions. The magnitude and direction of these changes varied for different regions of the country (U.S. Coast and Geodetic Survey 1957).

NAD 83 was officially completed in July 1986 using GRS 80 (Wade 1986, Morgan 1987, Snyder 1987, Doyle and Dewhurst 1989). NAD 83 is a geocentric datum, which means the reference ellipsoid coincides with the origin of the coordinate system - the earth's center of mass (Morgan 1987). The GRS 80 ellipsoid was accurately determined by numerous earth-orbiting satellites.

Map projections

The last crucial element of cartographic representation is map projection. A map projection is an ordered system of drawing parallels of latitude and meridians of longitude representing a round earth on a flat map. A great number of projections exist, each having its own advantages and disadvantages for varying scales and applications. Some of the more commonly used map projections include polyconic, Lambert conformal conic, Mercator, and transverse Mercator. Snyder (1987) is an excellent reference for descriptions and uses of various map projections.

By drawing latitude and longitude on a flat surface, it is possible to assign rectangular coordinates to any position on a map. These coordinates often become a standard of positional reference, as is the case with State Plane coordinates and Universal Transverse Mercator coordinates. Rectangular coordinate systems are defined by a datum and a map projection, with specific cartographic parameters for the map projection. Thus, it is important to know exactly the parameters for any coordinate system in order to accurately compare the location from one coordinate system with that from another.

Projection Manager

The MGE Projection Manager (MPM) addresses all of the geodetic variables discussed above, between various datums, projections, and coordinate systems. Also, primary and secondary coordinate systems can be defined so that positions can be obtained from two different coordinate systems in the same file. These functions are all accessed through a user-friendly graphical user interface as a module under MGE_SX. This section describes the workflow for setting up primary and secondary coordinate systems, as well as performing a map conversion. To access MPM functions, first display a design file from the MGE Project Manager menu, as described in the section entitled "Operation of MGE."

Coordinate system definition

The menu selections for defining coordinate systems are all shown in Figure A18. By selecting the **Sys** button, then the **Define** button, and then the **Prim Coord Sys** button, the Define Coordinate System menu is displayed (Figure A19). In the top center portion of the menu are three associated list fields, labeled **System, Geodetic Datum**, and **Ellipsoid**. Select the list icon at the right end of the **System** field. A list of 44 map projections and coordinate systems is displayed. Select the proper coordinate system by tapping a <D> on the name.

To the right of the **System** field is a button labeled **Params**. Select this button and the **System Parameters** submenu appears. On this menu, variables specific to each projection or coordinate system are set. When

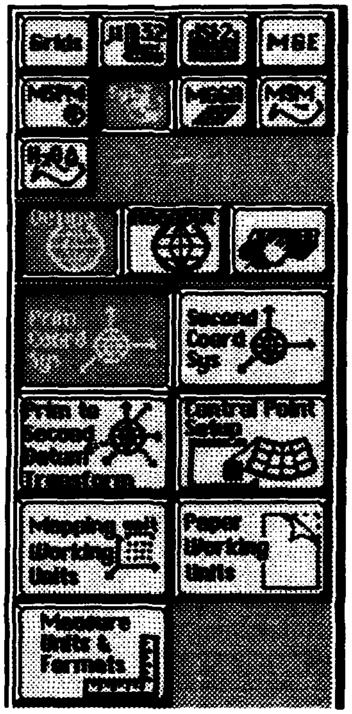

Figure A18. Buttom sequence for defining coordinate systems

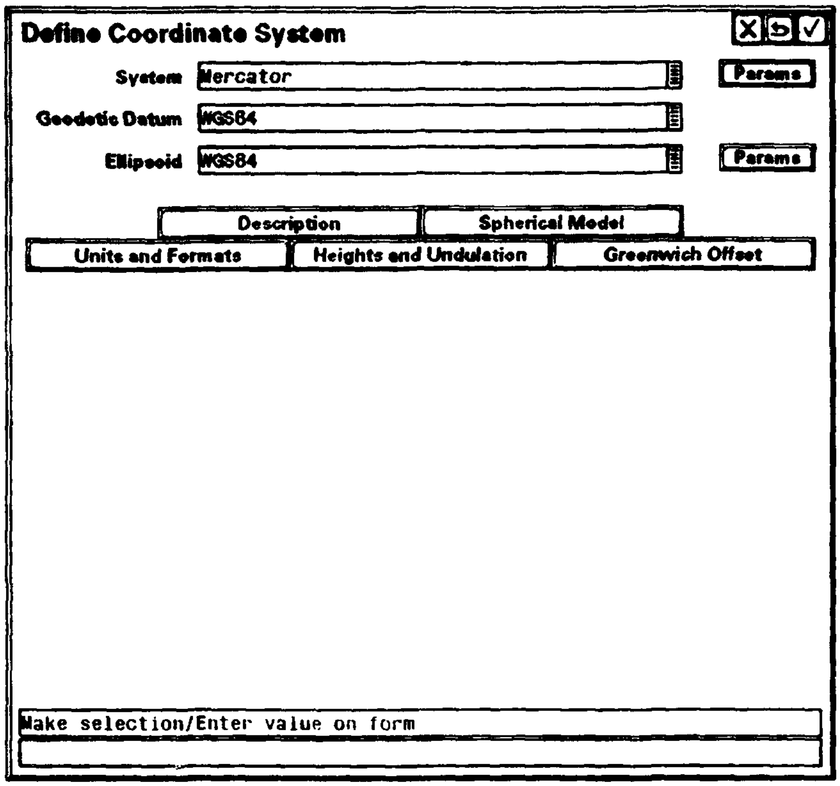

Figure A19. The Define Coordinate System menu

the coordinate system is **State Plane** , the only parameter that can be set is the zone. The projection parameters for each zone cannot be modified. The same holds true for Universal Transverse Mercator. If a generic projection is chosen, all parameters can be set. This is usually done to match the setup of a specific map.

Next, select the list icon in the **Geodetic Datum** field. A list of 25 datums is displayed. Many of these datums cover other parts of the earth and will be used rarely in the United States. Select the appropriate datum by tapping a <D> on the datum name. Notice that the **Ellipsoid** field is automatically updated when a datum is chosen. This is because a datum is defined partially by its ellipsoid, as described above. To the right of the **Ellipsoid** field is a **Params** button. By selecting this button, the mathematical variables for the definition of the ellipsoid can be reviewed. These fields cannot be modified.

Five buttons are located below the **Ellipsoid** field on the Define Coordinate System menu. These are labeled **Description, Spherical Model, Units and Formats, Vertical Datum/ Heights,** and **Greenwich Offset** . The **Description** button activates a menu that contains a field for input of key-in text. This can be a verbal description of the system setup for this design file. The **Spherical Model** button displays the Spherical Model submenu, which allows the

user to pick the spherical model type and to review or set the spherical model radius. More details on this are given in section 3.1.1.4 of the *MGE Projection Manager Reference Manual* (Intergraph Corporation 1991a).

The **Units and Formats** button activates a menu through which the units, precision, and formats of positions and displayed measurements are set. These will be the default units and formats for coordinate key-ins, unless a different unit is specified. The various settings for each of these are covered in detail in section 3.1.1.5 of the *MGE Projection Manager Reference Manual* (Intergraph Corporation 1991a).

The **Vertical Datum/Heights** button accesses a submenu for setting the vertical datum and type of heights measurements for 3-D files. This is covered in section 3.1.1.8 of the *MGE Projection Manager Reference Manual* (Intergraph Corporation 1991a).

The **Greenwich Offset** button displays a submenu in which an offset from the prime meridian in Greenwich, England may be specified. This will relocate the position of the meridian with 0 longitude. This is covered in section 3.1.1.9 in the *MGE Projection Manager Reference Manual* (Intergraph Corporation 1991a).

To set the secondary coordinate system, select the **Second Coord Sys** button from the panel menu. The **Define Coordinate System** menu is displayed, and the secondary system is set in the same manner as the primary coordinate system. The **Prim to Second Datum Transform** button activates the Define Datum Transformation menu (Figure A20). This menu consists of an associated list field, a description

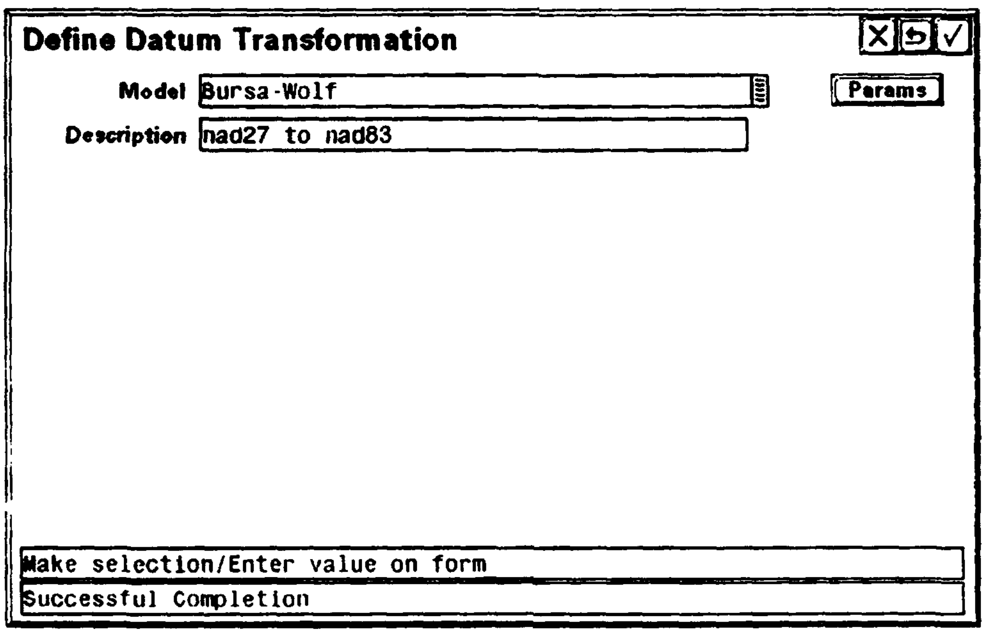

Figure A20. The Define Datum Transformation menu

field, and a **Params** button. When the list icon in the **Models** field is selected, a list of transformation models is activated. The most commonly used is NADCON, the official transformation model provided by the National Geodetic Survey for conversion between NAD 27 and NAD 83. The **Params** button activates a menu that is specific to the transformation model selected. The NADCON parameters menu contains only a toggle switch with selections of **To NAD83** and **From NAD83** . If the primary coordinate system is on NAD 27 and the secondary coordinate system is on NAD 83, select the **To NAD83** setting. If the primary is NAD 83 and the secondary is NAD 27, select the **From NAD83** setting. A detailed discussion of the datum transformation models is given in section 3.1 of the *MGE Projection Manager Reference Manual* (Intergraph Corporation 1991a).

The **Mapping Working Units** button activates a menu through which the file working units can be set (Figure A21). The primary unit of measurement (master unit) is set by selecting from a list of common mapping units (i.e., meters, feet, kilometers). The number of UORs per master unit is set in a key-in field labeled **Resolution** . **Storage Minimum Point** and **Storage Maximum Point** are updated automatically when the working units are set. The **Storage Center Point** gives the UOR coordinate for the origin point of the selected coordinate system. When the **Storage Center Point** is set, the **Storage Minimum Point** or **Storage Maximum Point** may be keyed in, and the other will automatically update. A complete discussion of working units is given in the section of this appendix entitled "Review of MicroStation Operations."

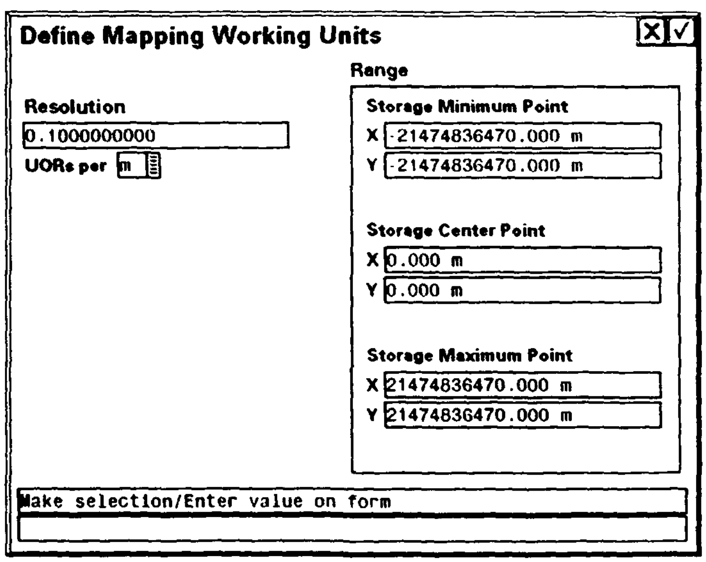

Figure A21. The Define Mapping Working Units menu

The **Measure Units & Formats** button activates a menu through which the readout units and precision for distance, angular, area, and volume measurements are set (Figure A22). The **Control Point Setup** and **Paper Working Units** functions are less commonly used, and are not covered in this text. They are explained in sections 3.1.4 and 3.1.6 of the *MGE Projection Manager Reference Manual* (Intergraph Corporation 1991a).

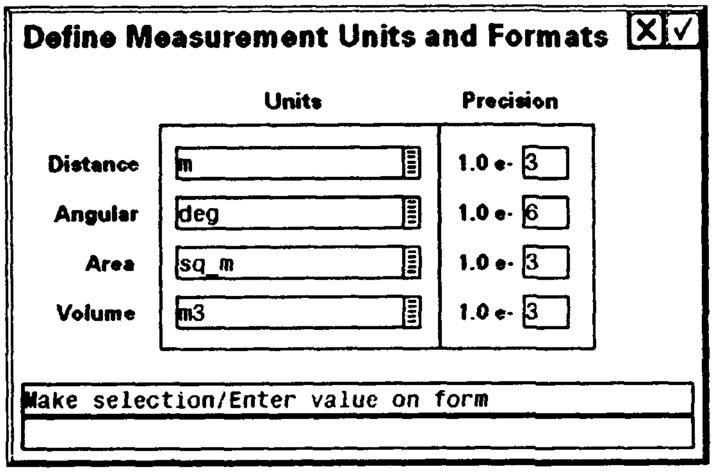

Figure A22. The Measure Units and Formats menu

Seed files

A set of coordinate system parameters that is likely to be used several times in a project is usually stored in a seed file. This is an empty design file that is copied to create new files. To set up a seed file, simply change the directory on the Select Map menu (Figure A14) from **dgn** to seed , and open or create a file. Then, perform the coordinate system settings operations discussed in this section.

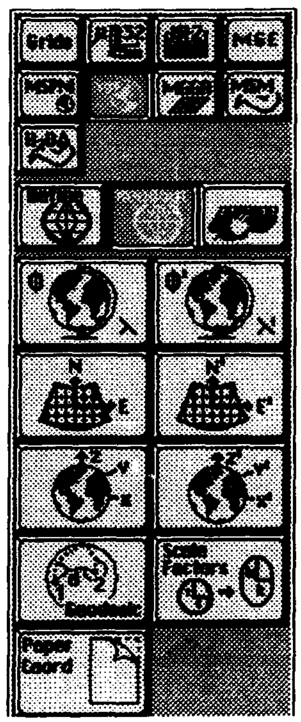

Figure A23. Button sequence for Coordinate System Readout commands

Coordinate system readout

The bar menu selections for coordinate system readouts are shown in Figure A23. The most commonly used selections are **Geographic Readout** , **Secondary Geographic Readout** , **Projection Readout** , and **Secondary Projection Readout** . **Geographic Readout** is the upper left of the buttons activated when the **Readout** button is selected. **Secondary**

Geographic Readout is to the right of **Geographic Readout** . **Projection Readout** is immediately below **Geographic Readout** , and **Secondary Projection Readout** is to the right of **Projection Readout** . Each of these commands allows the user to place a data point in a design file and obtain a coordinate readout for that point.

Geographic Readout displays coordinates in geographic, or latitude and longitude, values as determined by the primary coordinate system. **Secondary Geographic Readout** gives latitude and longitude values on the secondary coordinate system. **Projection Readout** displays the location of the point as projection, or easting and northing, coordinates as determined by the primary coordinate system. **Secondary Projection Readout** gives easting and northing coordinates from the secondary coordinate system. If the coordinate system is State Plane or UTM, the **Projection Readout** is identical to the State Plane or UTM coordinates. The other readout options available are described in section 3.2 of the *MGE Projection Manager Reference Manual* (Intergraph Corporation 1991a).

Coordinate precision key-in

To access Projection Manager precision key in commands, select the **Sys** button, then the **Precision Keyin** button (Figure A24). The most commonly used commands here are the **Geographic Precision Keyin, Secondary Geographic Precision Keyin, Projection Precision Keyin,** and **Secondary Projection Precision Keyin** . These commands allow the user to key in exact coordinates for input data points. For example, with exact corner coordinates for an area, the user could select a graphic element placement command, then select a precision key-in command, and key in the coordinates to place the element. The buttons have the same arrangement as those for **Coordinate System Readout** , described above. In addition to the precision key-in command, latitude-longitude values can be keyed in using the `ll=` command. The format for this command is `ll=DD:MM:SS,DD:MM:SS` . Decimals of seconds as well as decimal degrees may be keyed in.

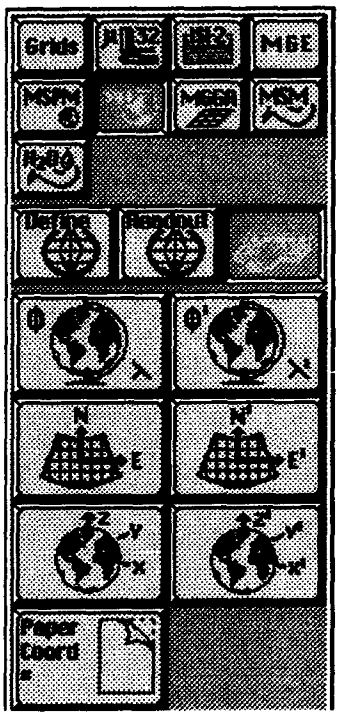

Figure A24. Button sequence for precision key-in commands

Coordinate system conversions

In addition to defining coordinate systems for map files, Projection Manager also provides utilities for converting between any of the defined coordinate systems. Select **MSPM** , and then the **Convert** buttons

to display the map conversion commands (Figure A25). The **Least Squares Fit** option allows transformation of the input map file to an output map file based on a matching set of weighted control points. This is discussed in detail in section 4.2 of the *MGE Projection Manager Reference Manual* (Intergraph Corporation 1991a).

The **Map Convert** command converts an input file with defined datum and projection parameters to an output file with a different set of datum and projection parameters. Selecting the **Map Convert** button displays the Map Conversion menu (Figure A26). The **Input Design File** is the active file. Tap a <D> in the **Output Design File** field to display a list of existing map files. Select a file name for the output file. The output file must already have the proper coordinate system defined. If the output file is in a different datum than the input file, the **Datum Transformation** toggle switch must be set to **YES**. The **Select Levels To Process** button activates a menu that allows selection of only certain levels to be converted to the new file. **Range Options** displays a menu that provides several methods for converting only a specific area to the new file. More information on less critical options can be found in section 4.3 of the *MGE Projection Manager Reference Manual* (Intergraph Corporation 1991a). When all of the map conversion options have been set, the execute button in the upper right-hand corner of the menu is selected to perform the conversion.

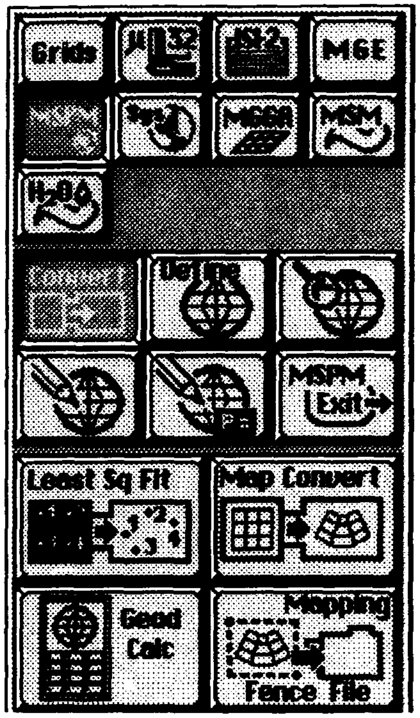

Figure A25. Button sequence for map conversion commands

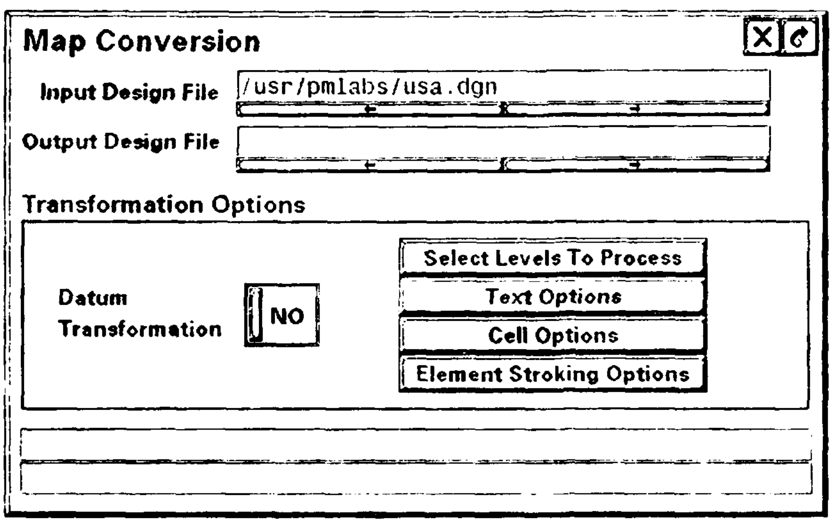

Figure A26. The Map Conversion menu

The **Geodetic Calculator** converts input coordinates from various sources to a different coordinate system. The input can be from data points, key-ins, or ASCII files, and the output can be a display in the menu or an ASCII file. This is a very useful utility that can be easily mastered with practice and guidance from section 4.4 of the *MGE Projection Manager Reference Manual* (Intergraph Corporation 1991a).

Coordinate system grid generation

The grid generation process allows the user to create a graticule of latitude-longitude or easting-northing values into a design file. Grid generation gives the user complete control of placement of a frame or neat-line, grid lines, tick marks, crosses, and labels. To access the grid generation commands, select the **Grids** button from the bar menu. The **Key-in** button activates the Grid Generation menu (Figure A27). Bounding coordinates of the grid can then be keyed in and parameters for placement of grid elements can be selected. The **Geo** and **E/N** buttons prompt the user to place a fence on the screen to define the limits of the grid. The **Geo** option places the grid by latitude-longitude, and the **E/N** option places the grid by easting-northing.

The grid generation program is very useful both in input and output of data. A grid can be created to match a map to be digitized, providing control points for digitizer setup. For output of final maps, grids are often needed for locational reference. The parameters set will vary depending on the input or output scale and the purpose for which the grid is created.

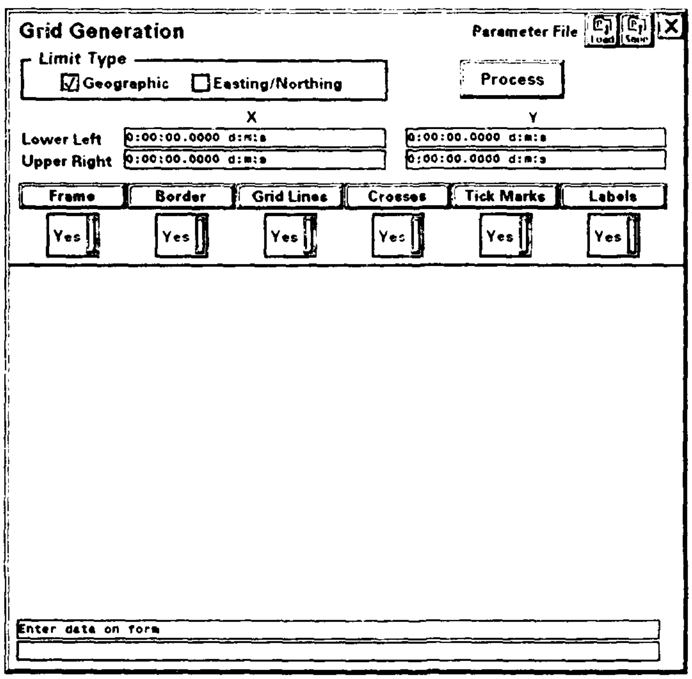

Figure A27. The Grid Generation menu

Practice will help to determine the particular elements and style one prefers for creating grids. Chapter 5 of the *MGE Projection Manager Reference Manual* (Intergraph Corporation 1991a) covers grid generation.

Reviewing Graphics and Database Attributes

This section provides a brief review of some of the commands for displaying design file data, changing active files, and attaching reference files. Also, the use of GeoDatabase Locate for reviewing database attributes and executing queries will be demonstrated. To begin, display a design file using the Select Map command on the MGE Project Manager menu.

Select the **MGE** button, then the **Design Files** button, then the **Design File Display** button from the bar menu (Figure A28). The Design File Display menu will be activated (Figure A29). The active project directory is displayed at the top of the menu. Below the **Active project directory** field, in the **Available directories** field, all sub-directories of the project directory are listed. The active directory is highlighted in this list. The default is the **dgn** directory. The active directory can be changed by selecting another directory from the list. Below the directory list, the active design file is displayed. Below the active design file, a list of all files in the active directory is displayed under the label **Available design files**. All **Attached reference files** are also listed. A file can be selected from either of these lists, and its name will be displayed in the field below the lists. The option buttons will become active when a file is selected. **Change files** will make the selected file the new active file and attach the current active file as a reference file, keeping the same display configuration currently set. **Retrieve file** will close the currently active file and make the selected file the active file. **Attach file** attaches the selected file as a reference file, and **Detach file** detaches a currently attached reference file.

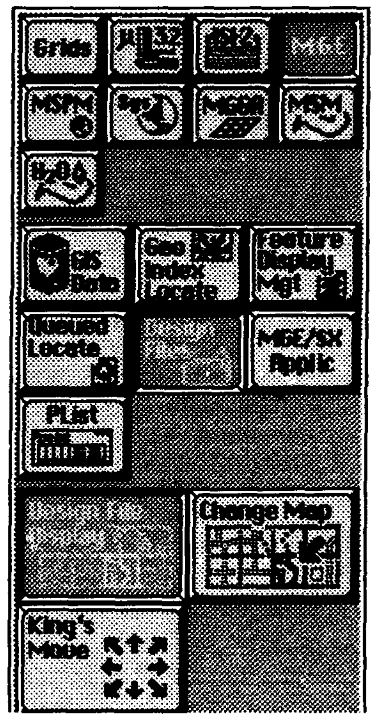

Figure A28. Button sequence for Design File Display commands

The **Change Map** button on the panel menu performs a similar action to the **Change Map** button on the Design File Display menu. When the **Change Map** button is selected, the software displays two prompts: (1) **identify element/reset to exit**, and (2) **RF**

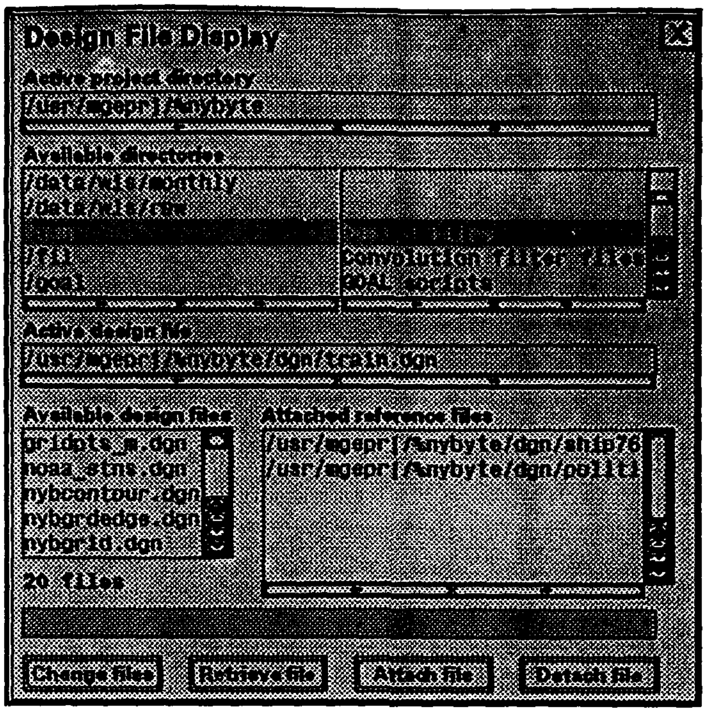

Figure A29. The Design File Display menu

Name or Logical . The user can tap a <D> on a displayed graphic element. If that element is in a reference file, the software prompts: **Accept/reject** . Select a <D> to accept or <R> to reject. If the user accepts, the file that contains the selected element will become the new active file, while maintaining the same display configuration currently set. Or, at the **RF Name or Logical** prompt, simply key in the name or logical name of a reference file. The reference file will become the active file, while the display remains the same.

GeoDatabase Locate

GeoDatabase Locate (GDL) is one of the most powerful aspects of MGE. It provides an easy interface for performing joint queries on graphics and the attached database. A graphic element can be selected and its database attributes reviewed. Values for database table fields can also be filled in and all graphic elements that fit the query can be found. Many other query options are available through GDL. In fact, section 21 of the MGE/SX Reference Manual, Volume II, (Intergraph Corporation 1992c) contains approximately 100 pages of text describing functions and operations. As such, only the main points of GDL will be discussed below.

To access GDL, select the **GeoDatabase** button from the MGE Project Manager menu. This will display the *work.dgn* file and bring up the GDL menus (Figure A30). Select the **New Query Subject** on the

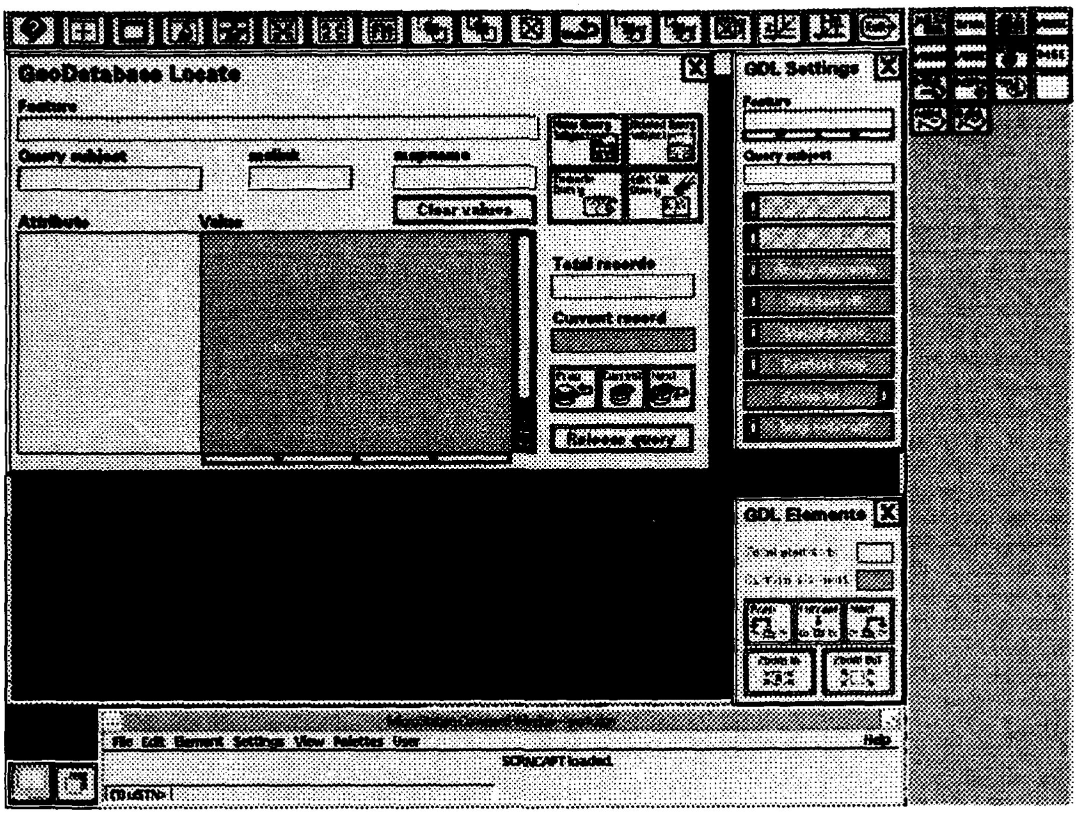

Figure A30. The GeoDatabase Locate menus

GeoDatabase Locate menu. This will activate a menu that lists all features and database tables defined for the project (Figure A31). Select **noaa_stns** from the list of features, and then the check-mark button. When returned to the GeoDatabase Locate menu, notice that the fields for the database table for National Oceanic and Atmospheric Administration (NOAA) stations are displayed. Select **Execute Query** , and a search will be performed for all records in the table. A total of 10 records were found, as indicated in the **Total records** field. The first of these 10 is currently displayed, as indicated by the **Current record** field. Move the cursor to the **GDL Settings** menu, and switch the top toggle from **Locate record off** to **Locate record on**. A **Locating...** message appears in the MicroStation command window, and the *noaa_stns.dgn* file, which contains all of the NOAA station locations, is retrieved. The element corresponding to the current record is highlighted and centered in View 1. Selecting the **Next** button on the GeoDatabase Locate menu locates the next database record and its corresponding graphic element. The **Next** and **Previous** buttons can be used to browse through the records retrieved.

Select the **Release Query** button, and the current search will be erased. Now, on the bar menu, select the **MGE, GIS Data** , and **GDL Query** buttons in succession (Figure A32). Then select the **Review Graphics** button. A prompt is displayed to **Identify element/reset**

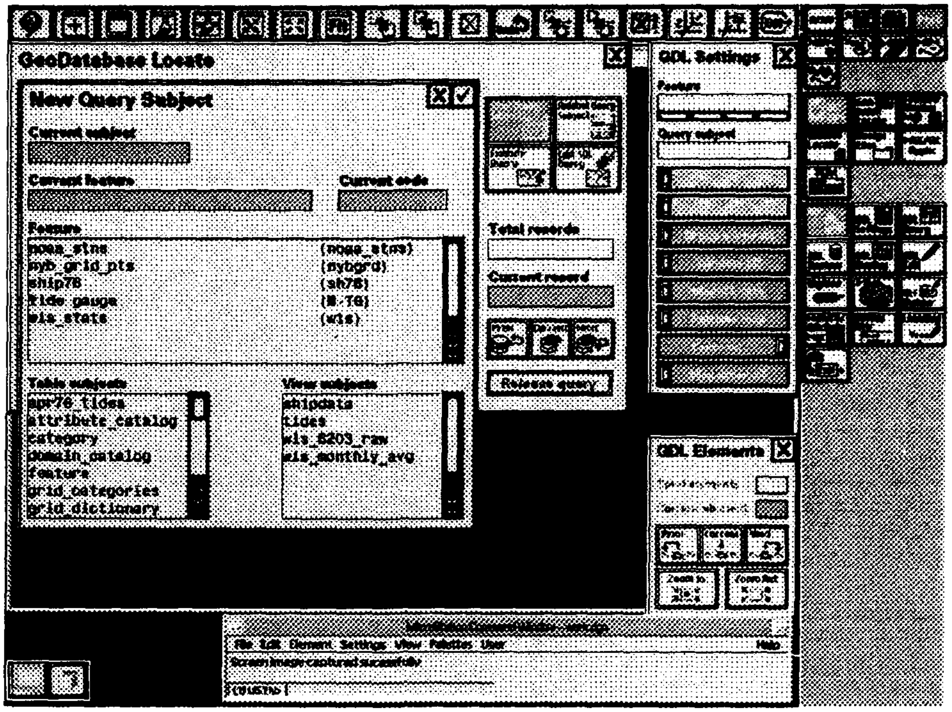

Figure A31. The New Query Subject submenu of GeoDatabase Locate

to exit. Select a graphic element by tapping a <D> and then tap another <D> to accept the highlighted element. The database record corresponding to the element selected is located and displayed in the GeoDatabase Locate menu.

GDL can also be used to query database records not attached to graphics. Records can be inserted, modified, and deleted through GDL. SQL statements can be edited to perform more complex searches, and these statements can be saved to text files for later use. There is also a report generation utility that provides report output and formatting capabilities.

MGGA

MGGA is a full-featured raster GIS package that operates as a module under MGE_SX. It includes utilities for input, editing, analysis, and output of data, as well as conversion routines to and from certain raster formats. This section discusses the basic commands needed to control the display of grid files. Some of the analysis functions will be covered in the sample project portion of the course.

To access the MGGA display functions, select the **MGGA** button, then the **Display** button from the panel menu (Figure A33). Selecting the **Grid Display Manager** button activates the Grid Display Manager

menu (Figure A34). To read in a grid file for display, key in the grid file name in the **Load Grid File** field. Alternately, select the associated list to display a list of available grid files, and select a file name from the list. Then, select the **Load** button to load the file. Although several grid files can be loaded at once, one is designated the active file and its name is displayed in the **Active Grid File** field. To change the active grid file, select the associated list, then select one of the loaded files from the list to become the active file. Or, if a new file is loaded, it automatically becomes the active file. Below the **Active Grid File** field, a list of all loaded files is given, with display parameters for each in columns to the right of the file name. The **Priority** column indicates the order in which the files are displayed, if more than one is displayed simultaneously. **Views** columns 1-8 represent MicroStation views. If a column is empty, the grid file is currently not displayed in that view. If the grid file is displayed in a view, the word **On** is displayed in the corresponding view column. The **Interval** column indicates the range of values in a grid file to be displayed as a single color. The **First Slot** column indicates the number of the color representing the first interval displayed. The **Last Slot** indicates the last color used. To select a color for these columns, place a <D> in the column aligned with the file name to be affected. A menu appears showing the colors available from the currently defined color table. Select a color by tapping a <D> on the desired color. The **Delay Update/Update Immediately** toggle switch controls when the views are refreshed to reflect changes in the display parameters. The default setting is **Delay Update** , which means that the views are updated when the Grid Display Manager menu is exited. When set to **Update immediately** , the views update whenever a change is made to any display parameter on the Grid Display Manager menu.

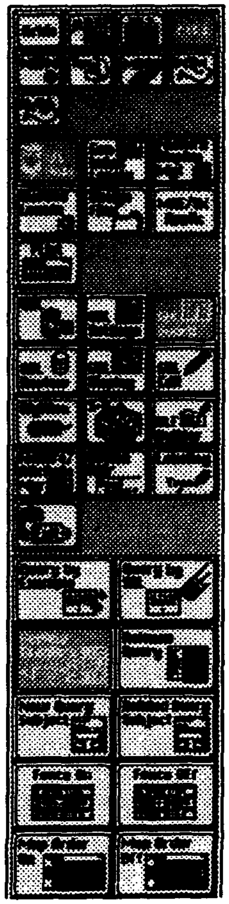

Figure A32. Button sequence for Review Graphics

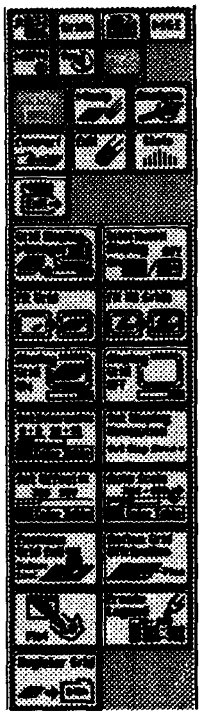

Figure A33. Button sequence for MGGA display commands

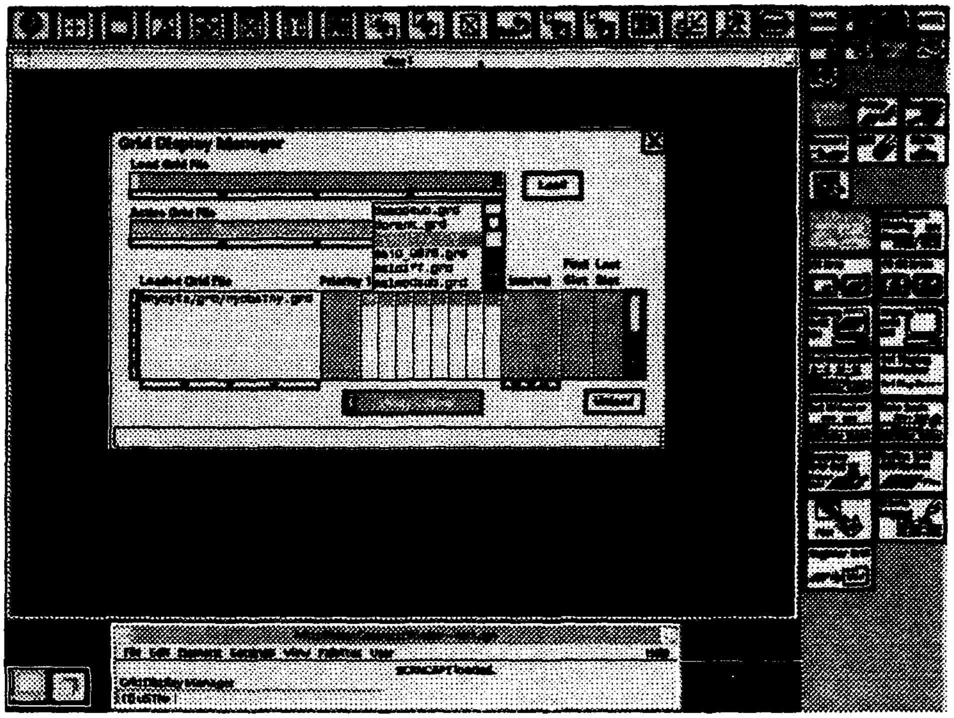

Figure A34. The MGGA Grid Display Manager menu

When a grid file has been loaded for display and the Grid Display Manager menu has been exited, the views identified for display of the grid file often are not set to the proper area. The **Fit Grid** command operates similarly to the **Fit Active** command in MicroStation in that it determines the extent of the active grid file and sets the view area to correspond to the file limits. After selecting the **Fit Grid** button, a **Select view** prompt is displayed. Place a <D> in the desired view, and the view updates. **Fit All Grids** performs the same function, except it determines the combined extent of all grid files currently displayed for a selected view.

Display Grid On and **Display Grid Off** affect the display status of the active grid file. After selecting one of these commands, a **Select view** prompt is displayed. Place a <D> in a view to turn the display on or off and the view will update automatically.

The **Examine Grid Cell** command allows the user to identify a position and review the value in the active grid file at that position. After selecting the button, the prompt **Identify grid cell** is displayed. Place a <D> in a view, and the software displays the row number, column number, and value for that cell.

A legend for the current display setting of the active grid file can be generated using the **Create Leg** command. Upon selecting the **Create Legend** button, the Cr end menu is activated

(Figure A35). The active grid file is displayed at the top of the menu, and a key-in field for the title of the map is immediately below. Four columns are displayed that control the contents of the legend to be created. The first column indicates the color of the range of values displayed. The second column indicates the range of values. The third column is a key-in field for descriptions of each range, and the fourth column is the area calculated for each range. The **`Place range`**, **`Place description`**, and **`Place area`** boxes indicate whether each of these items is to be included in the legend. To select or deselect these, a <D> is placed in the corresponding box.

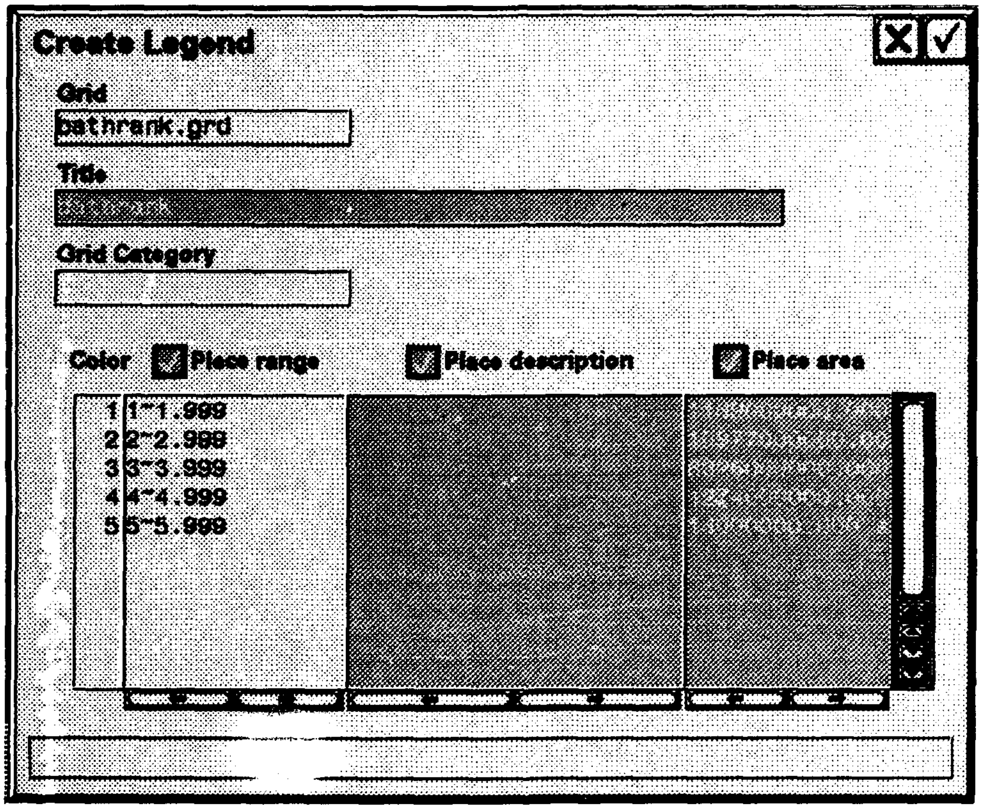

Figure A35. The MGGA Create Legend menu

MTM

MTM is a software module that provides surface model creation, display, and analysis. The basic display features are discussed in this section, while some other functions are discussed in the sample project portion of this manual. Before displaying data in MTM, a 3-D design file must first be opened.

MTM reads from three types of data files. An *.xyz* file is a binary file format containing surface feature definitions, a *.ttn* file contains a Triangulated Irregular Network model, and a *.grd* file contains a grid surface

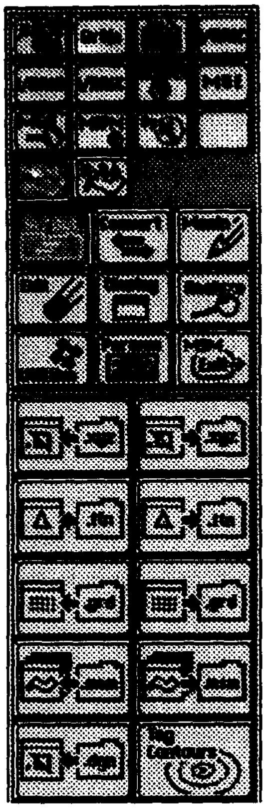

Figure A36. Modeler In/Out command buttons

model. To access the commands to read in models, the user selects the **MSM** button from the panel menu, waits for the **MSM ready** message, then selects the **In/Out** button. The commands available for reading from and writing to files are displayed (Figure A36). The **load features from .xyz** command is the upper left button, with the **load TIN from .ttn** and **load grid from .grd** immediately below. When one of these is selected, a menu is activated that displays all available files of the selected type. Select the file name to be loaded by tapping a <D> on the file name, then select the check-mark button to load the file. When features are loaded from an *.xyz* file, they must be converted to a TIN model before display. To access the conversion commands, select the **MSM** button, then the **Convert** button from the panel menu (Figure A37). The **convert features to TIN** is the upper left button. The upper right button is the **convert TIN to grid** command, the lower right button is the **convert grid to TIN** command, and the lower left button is the **convert grid to features** command.

When MTM is initiated, the Display Model Status menu is displayed at the bottom of the panel menu (Figure A38). The upper left button indicates the type of model currently active. Figure A38 indicates that a grid file is active. The other model types are TIN, indicated by a triangle, and watershed, indicated by two drops of water. The middle button is a **Display/Place** toggle. When set to **Display**, the elements of the model are displayed temporarily and will disappear when the view is updated. When set to **Place** , the elements are actually placed into the current design file. The **X** button deletes the Display Model Status menu. The field at the bottom indicates the active model. If more than one model is loaded, the active model can be changed by selecting the associated list, then selecting a model name from the list.

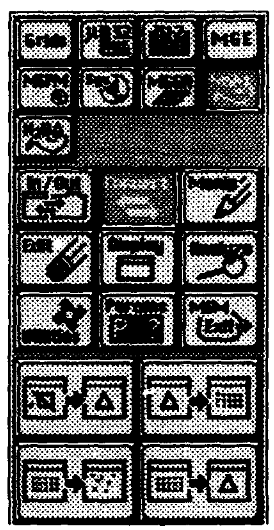

Figure A37. Modeler file conversion commands

Selecting the **MSM, Params** , and **Display Params** buttons from the panel menu activates the Display Parameters menu (Figure A39). All aspects of the display of models can be controlled through the Display Parameters menu

(Figure A40). At the top center of the menu is a field labeled **Parameter File** . A parameter file, or *.mpf* file, contains all parameter settings available in the Display Parameters menu. The current parameter file is displayed, and an unlimited number of parameter files may be created. To set a new active parameter file, select the associated list icon, select a parameter file name, then select the **Load** button. If changes are made to any of the parameters, the **Save** button can be used to save the changes to the current parameter file or to create a new one.

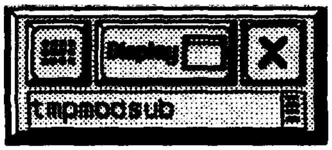

Figure A38. Display Model Status menu

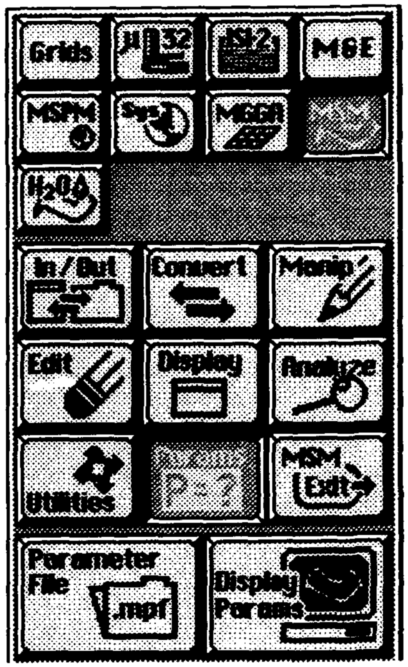

Figure A39. Button sequence for Modeler Display Parameters commands

Display of model data is controlled by options in the **Symbology Table & File** area of the Display Parameters menu. There are three different types of symbology tables. Several tables of each type may be saved, and all tables are accessible from any parameter file. An interval table assigns colors to ranges of values defined by a constant interval (i.e., change color every 10 m). A Major/Minor table provides symbology definitions based on repetitive use of two basic symbologies (i.e., thick lines for every fifth contour and thin lines for intermediate ones). A key-in table allows for user-defined ranges and symbologies. This is used if the sizes of ranges are variable and/or if the colors desired are not in order in the color table. Only one symbology table may be active at any time. The active type is indicated by the check mark boxes. The active symbology table is displayed in the field at the bottom of the **Symbology Table & File** area. The active table can be changed by selecting the associated list icon and selecting a file name from the list.

After selecting the appropriate display symbology, model data can be displayed. Select the **MSM** button, then the **Display** button to show the display options (Figure A41). The **Fit Model** button adjusts the selected view to correspond to the extent of the active model. The **All Features** and **Selected Features** can only be used with TIN models, and display different features defining the model by symbology set on a subsequent menu. The **TIN** button produces two options for

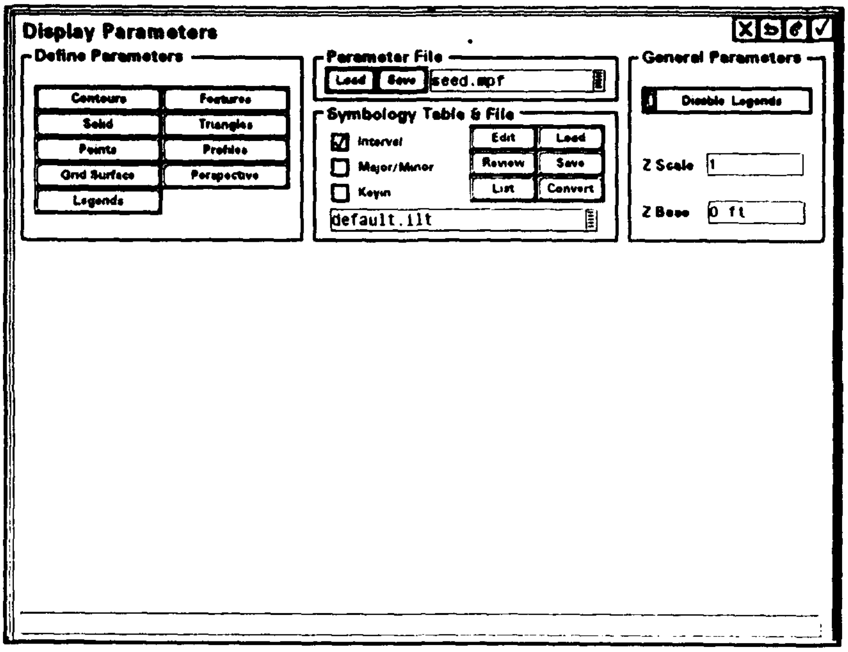

Figure A40. The Modeler Display Parameters menu

displaying TIN models: **display by symbology table** and **display by symbology. Display by symbology table** uses the symbology set in the Display Parameters menu. **Display by symbology** displays the entire model with a single symbology set in a subsequent menu. The **Profiles** and **Grid Surface** buttons operate only with grid files. These also have the symbology table and symbology options. The **Color Coded** option produces a solid color display based on the active symbology table. This also works only with grid files. The other options are more advanced functions that are beyond the scope of this course. They are described in detail in the *MGE Terrain Modeler Reference Manual* (Intergraph Corporation 1992b).

The **Probe Model** command allows the user to place a <D> anywhere within the bounds of a model and display the Row and Column number (for grid files only), the x, y, z, slope, and aspect values for that point. It also allows placement of a text label in the design file showing the z, slope, and/or aspect. To access **Probe Model** , select the **MSM** button, the **Analyze** button, then the **Probe Model** button from the panel menu. The **Probe Model** function only works in top view.

MTM and MicroStation provide features for viewing surface models in three dimensions. First, there is a defined view named **iso** . To set a view to isometric, key in `vi=iso` , then select a view to change. The Z scale can be set in the Display Parameters menu to provide vertical exaggeration. Press and hold a <D> on the **View** selection in the MicroStation command window, then move the cursor to **Rotation** and release the <D>. The View Rotation menu is activated (Figure A42). This is an

easy-to-use method of setting oblique views in 3-D. The box on the left represents the current orientation of the view number displayed. Orientation of the box can be changed by pressing and holding a <D> on the arrows on the right side of the menu. When the box is at the desired position, select the **Apply** button, and the view will be changed to match the selected orientation. The button labeled **Std.** contains several standard views that have preset definitions, which can also be used to set the orientation of views.

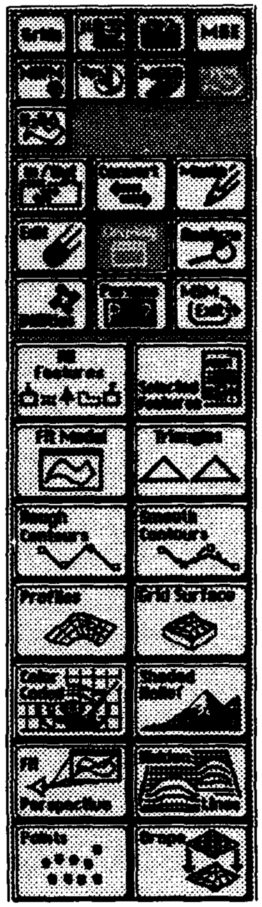

Figure A41. Button sequence for Modeler Display Options

Sample Project

In this part of the course, data will be extracted from the database to create TIN and grid models in MTM, volumes will be calculated in MTM, and MGGA will be used to perform analysis on grid files. The MTM portion of the project compares data extracted from a hydrodynamic model of the New York Bight with similar data from shipboard observations. The MGGA portion of the project deals with identifying criteria for siting a dredged material disposal site in terms of bathymetry and dissolved oxygen. Then, the bathymetry and dissolved oxygen data will be analyzed to identify potential sites. This project is not intended to be a thorough scientific investigation of these questions. Rather, it is intended to introduce the basic concepts and functions of GIS analysis and illustrate some of the potential applications.

To begin the project, log in to the workstation and start MGE. Select **train1** as the active project, then open a VT window from the MGE Project Manager menu. Key in `ls -l` to see all files and directories. Key in `cd data/shipdat` to change directories to the directory in which shipboard observation data will be stored.

Shipboard observation data have previously been loaded into Oracle database tables. The SQLPlus utility will now be used to extract certain data for use in the project. At the Unix prompt, key in `sqlplus` . The system will prompt for a user name. This is an Oracle user name, not a login ID. Key in `train1` , then key in `train1` as the password. A **SQL>** prompt will appear. Now, enter the following SQL statement:

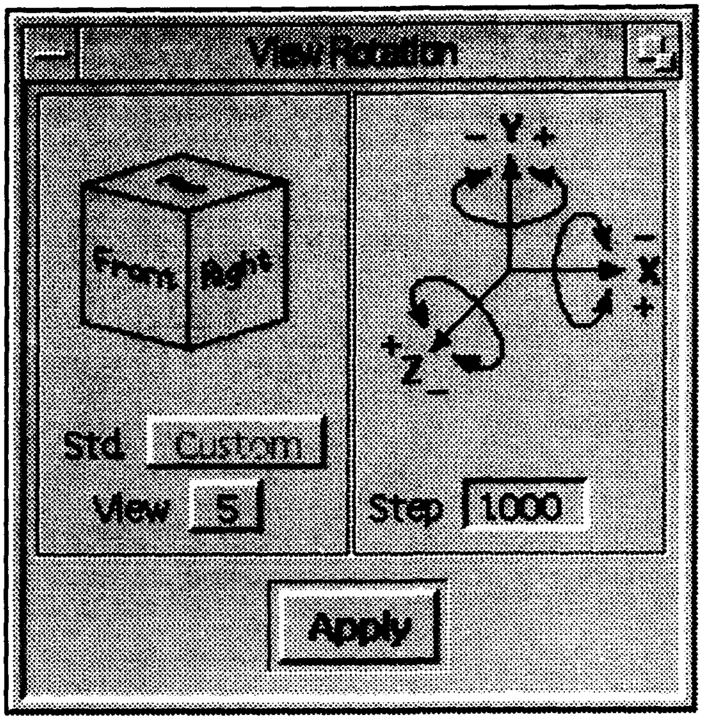

Figure A42. The MicroStation View Rotation menu

```
select longitude,latitude,salinity from shipdata where
obs_date between 760815 and 760914 and
(sample_depth is null or sample_depth between -1.0 and 0.0) and
salinity != -9;
```

When the user enters `<return>` after the ending semicolon, the software searches the database and displays the query results. If, after reviewing the query, the user decides that it is in fact the required data, the output can be saved to a file. Key in `spool filename` , where `filename` is the name of the file you wish to create. Then, key in the above SQL statement. When finished processing, the **SQL>** prompt will reappear. Key in `spool off` to stop entering data. Key in `exit` to end the SQLPlus session and return to the Unix prompt.

By keying in `ls` , the new file name should be listed in the current directory. Key in `iedit filename` to display the file. The SQL statement is included in the file, as well as column headers. These lines are not needed to load the data into the GIS, and must be edited out. A previously edited version of the new file exists in this directory with the name *sa760901.dat.* Use this file for the next step.

The file *dat2mst* is an executable file that converts data files from a simple x,y,z format to a file containing MicroStation element placement commands. This program creates a file that is read by MicroStation to enter points into a design file having the values derived from the SQL statement. To run the program, key in `./dat2mst sa760901.dat`

sa760901.mst . The program asks if the data are in UTM or Latitude-Longitude. Key in 1 to indicate latitude-longitude coordinates. The program executes, and you can see the new file by keying in ls . Notice the two files *te760901.dat* and *te760901.mst*. These are temperature files derived from shipboard observations, similar to the salinity files just created. The user deletes the VT window and returns to the MGE Project Manager menu.

The next step is to create new design files into which salinity and temperature data will be loaded. Select the **Select Map** button to display the Select Map Menu, then key in salinity.dgn in the **File name** field. When the Create Map menu appears, select *seed3d.dgn* as the seed file to create the map. Next, activate the Design File Display menu. Scroll through the available design files, select *shoreshape.dgn*, and attach it as a reference file. Then select the **Fit All** command from the **View** menu on the MicroStation Command Window. Key in file or <ctrl/f> to save the current display settings for the file. To create the temperature file, key in temp.dgn in the file name field at the bottom of the Design File Display menu. Once again, select *seed3d.dgn* as the seed file. Select the check-mark button to create the map and return to the Design File Display menu. The new file remains selected. Select the **Retrieve file** button to display the new file.

Next, place the temperature data into the *temp.dgn* file as text strings. The previously created *.mst* file will place text strings showing the value from the database at the proper x,y,and z coordinates. Begin by setting the active level and color, by either keying then in or using the Element Attributes menu. To set the text attributes, press and hold a <D> on the **Element** menu, then move the cursor to **Text** and release the <D>. On the text settings menu that appears, set the font to 1, the height and width to 500, the line spacing to 250, and the text justification to center. Dismiss the menu by double clicking in the upper left-hand corner. Key in @/usr/mgeprj/train1/data/shipdat/te760901.mst at the **uSTN** prompt. Use the MicroStation view control commands to examine the file contents.

Next, place the salinity data into the *salinity.dgn* file. Use Design File Display to change maps, and repeat the procedure for temperature data, using the *sa760901.mst* file to place the data. Once again, use the view control commands to examine the contents. You will find that there are positions with duplicate values and some values that appear in error due to large differences between neighboring points. Initiate MTM and select the **load features from .dgn** command. Key in a model name and select the level on which you placed the temperature data. Select the check-mark button and wait for the **Successful Completion** message. Select the **convert features to TIN** command and process the conversion. Then select the *salinity.mpf* parameter file on the Display Parameters menu. Select the **Fit Model** command to set the view area, then display smooth contours. You will notice some

"bulls-eye" contours that imply erroneous values. This is one way in which MTM can be used to verify data validity.

Due to time restrictions, previously edited temperature and salinity files will be used for the following steps. Display the file *te760901.dgn*, which contains text strings representing temperature values derived from shipboard observations. Activate the **load features from .dgn** menu. Key in the model name te760901. Select the level to be processed and select the check mark to exit the menu.

When the **Successful completion** message is displayed, select the **convert features to TIN** button and process the conversion with the default values on the menu. Next, display the Display Parameters menu and select the parameter file *temp.mpf*. Then display the TIN model by symbology table, and draw the legend.

Activate level 2 to display a data boundary polygon. You may need to use **Fit Active** to see the polygon displayed. This boundary was drawn in conjunction with the limits of the salinity data because two TIN files must have identical boundaries to subtract them and create a difference model. Select the **Manip** button, then the **Project Z** button. Project Z drapes an element on the active surface model. The software prompts the user to **Identify element/<R> to continue.** Select the shape by placing a <D> on the element, then accept the highlighted element by placing another <D> in the view. If other elements were to be manipulated, they could be selected at this time. Because there is only one element, tap <R> to continue. The Project Feature to Model menu is displayed. Keep the defaults for **Feature Densification** and **Feature Vertex Inclusion**. Toggle the **Exclude Features** switch to **No**, and enter an unused level for output features. Select the check-mark button to begin processing. When the **Successful completion** message is displayed, activate the **load features from .dgn** menu. Select the model name from the associated list, set the feature type to **Edge**, and set the level to the output level for the Project Z command. Select the check-mark button to exit and process. When the **Successful completion** message is displayed, convert features to TIN, accepting the defaults on the menu. When this process is complete, display the TIN model by symbology again, and notice that it does not extend past the defined boundary.

Select the **Utilities** button, then the **Rename Models** button. Tap <R> to display a list of all models currently loaded. Select the model to be renamed, then key in the new name in the **New Model Name** field. Rename *te760901* to *tmpshpsub*. Then select the **In/Out** button, and the **TIN to .ttn** button. This saves the active model to a file. Next, change design files to *sa760901.dgn*, and repeat the above procedure for the salinity data. When the model is complete, rename the model to *salshpsub* and save it to a *.ttn* file.

In this section, temperature and salinity models that were created from data extracted from hydrodynamic model output will be loaded. These have previously been saved to *.ttn* files. To begin, select the **load TIN from .ttn** button. Select the *salmodsub.ttn* and *tmpmodsub.ttn.* These contain salinity (*salmodsub.ttn*) and temperature (*tmpmodsub.ttn*) surface models derived from hydrodynamic model output, and subset to match the above-mentioned boundary. When these are loaded, select the *temp.mpf* parameter file for the temperature model and the *salinity.mpf* parameter file for the salinity model. Display each of the models, along with their legends, and examine the density and smoothness of these compared to the models derived from ship observations.

Two models of the same parameter for approximately the same time period and the same geographic area now exist. The only difference is the source of data used to create them. Using the MTM **Compute Volume** function, the differences between the two models can be easily quantified. Choose the *tmpmodsub* model as the active model. Select the **Analyze** button, then the **Volume** button. On the Compute Volume menu, the active model is the **Primary Surface** (Figure A43). The **Secondary Surface** can be either a constant elevation or another TIN model. Set the toggle switch to **.ttn File/Model**, then select the *tmpmodsub.ttn* file from the associated list as the Secondary Surface. **Computational Extent** can be either the entire model or within a polygon at a specified level. Set the toggle to **Entire Model**. To

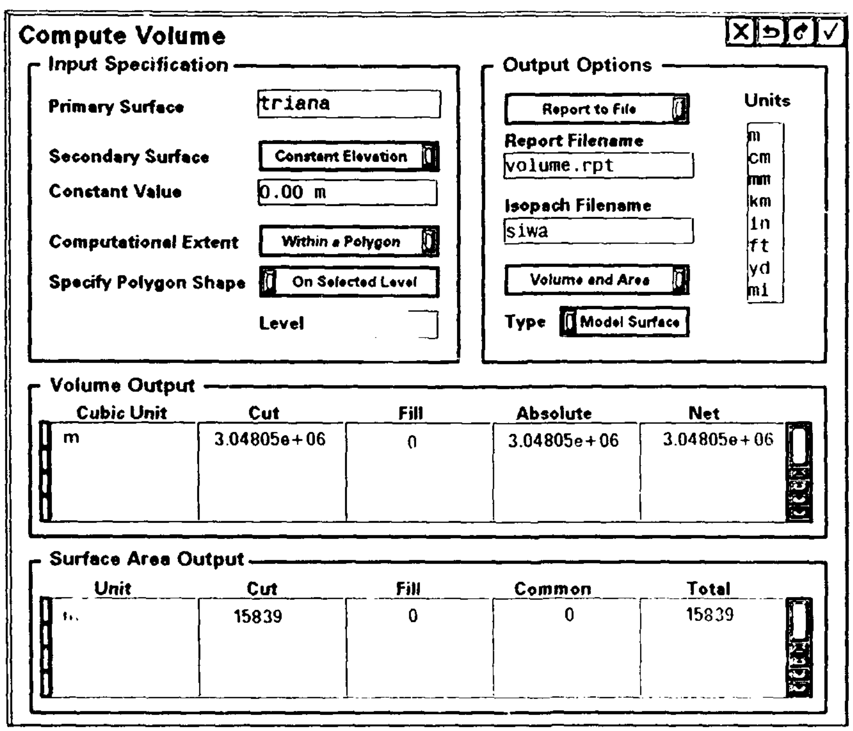

Figure A43. Modeler Compute Volume menu

write the text output of cut-and-fill values to a file, set the toggle under **Output Options** to **Report to File**. Then key in *tmpdiff.rpt* as the name of the file to be created. A difference, or isopach, TIN model can be created by keying in the file name to be created. Key in the name *tmpdiff.ttn* so that the results can be loaded and displayed. Select the desired units of the output report. More than one type of measurement unit can be selected. Select the execute button to perform the difference calculation. Cut, fill, absolute, and net values are displayed in all units selected. These values are also output to the report file.

Now, exit out of the Compute Volume menu and select the *salmodsub* model as the active model. Use **Compute Volume** to subtract this model from the *salshpsub* model, and output a report file (*saldiff.rpt*) and *.ttn* file (*saldiff.ttn*). When complete, use the **load TIN from .ttn** command to load the two difference models. Select the *saldiff.mpf* parameter file for the *saldiff* model, and the *tmpdiff.mpf* parameter file for the *tmpdiff* model. Display the two TIN models and investigate the differences displayed.

Spatial Analysis

In this part of the course, various MGGA commands will be used to load, display, and overlay grid files. Bathymetry and dissolved oxygen data will be used to find potential dredged material disposal sites. The first step will be to determine the depths and dissolved oxygen levels that are best-suited for disposal. Previously created bathymetry and dissolved oxygen grid files will then be loaded and displayed, legends will be created, and possible relationships between the two will be visually examined. Finally, Intergraph's Geographic Oriented Analysis Language (GOAL) will be used to classify and analyze the data, and produce an output map of the best and worst potential disposal sites, based on the criteria set.

The first step is to define the criteria for placing dredged material in terms of bathymetry and dissolved oxygen. What depth or range of depths is best-suited to disposal? What depths are worst? Are there any critical levels of dissolved oxygen that may determine existing "dead zones"? What levels of dissolved oxygen should absolutely be avoided? Is one of these two parameters far more important than the other (is weighting needed)? It may be helpful to display the available data to examine existing conditions for clues in setting criteria. If so, skip ahead to the next section and then use the worksheet below to fill in the ranges of depth and dissolved oxygen values and their rankings (Tables A2 and A3). Another function that may be useful in filling in the worksheet is statistics calculations. To access this, select the **MGGA** button, the **Stats** button, then the **Statistics** button. A menu is activated that requires the user to select the input grid file from an associated list. Select the **Execute** button, and the minimum, maximum, mode, mean, median, variance, and standard deviation are calculated and displayed.

Table A2
Bathymetry Grid File Classification Worksheet

Weight =		Parameter = Bathymetry
Input Range	**Output Class**	**Description**

Table A3
Dissolved Oxygen Grid File Classification Worksheet

Weight =		Parameter = Dissolved oxygen
Input Range	**Output Class**	**Description**

The second step is to load the proper grid files. Use the MGGA Grid Display Manager to display the files *bathysub.grd* (bathymetry) and *domodsub.grd* (dissolved oxygen). Experiment with the display interval for both files to see what ranges of the data may be useful to work with. After the ranges and rankings of values have been determined, the files need to be reclassified. This means that, instead of having a nearly infinite number of real values in a grid file, it will be reduced to a small number of classes. All pixels that were in a specified range will be reassigned a single integer value. For example, if the ideal depth for a disposal site is 20-200 m, then all pixels having a value of between 20 and 200 might be reclassified with a value of one. To perform the reclassification, select the **Analyze** button, then the **Overlay** button. The Overlay menu is displayed. Select the input grid file (*bathysub.grd*) from the associated list, then key in an output grid file name (*bathyrank.grd*). Select the *bathrank.g* file from the **Overlay GOAL Script** associated list, then select **Load** to display the script. To modify the script, select the **Modify** button. A sample GOAL script with explanations of each line is given below:

float i1; Indicates that values from the input file are floating point numbers
int o1; Indicates that values for the output file are integers
if i1 = void
then
  o1 := void; If the input file has a void pixel, that pixel is also void in the output file
else
  if i1 >= 0.0 then o1 := void; Because the input data is in negative numbers, any positive numbers are voided
else
  if i1 >= -6.0 and i1 < 0.0 then o1 := 5; values between 0 and -6 are assigned a value of 5
else
  if i1 >= -20.0 and i1 < -6.0 then o1 := 1;
else
  if i1 >= -50.0 and i1 < -20.0 then o1 := 2;
else
  if i1 >= -100.0 and i1 < -50.0 then o1 :=3;
else
  if i1 <-100.0 then o1 := 4; All values less than -100 are assigned a value of 4
endif Ends of if statements
endif
endif
endif
endif
endif
endif

Modify this file to fit the criteria set for bathymetry. After modifying and saving the script, return to the Overlay menu and select the **Execute**

button. The Process Start Mode menu appears. Select **Execute and continue** to submit the process in batch mode and continue working. The process is displayed in the Process List, which will display a **Complete** message when done. Next, perform the same operations using the file *domodsub.grd* as input, *dorank.grd* as output, and *dorank.g* as the GOAL script.

When both reclassifications are complete, load and display the output files using the Grid Display Manager. Set the interval to one for both files and examine the areas of equal ranking you have created. If these are satisfactory, proceed to the next step and overlay of two files. If not, repeat the previous exercise.

Activate the Overlay menu and select the two classified files that were created as input files. Key in *disposal.grd* as the output grid file name and load *disposal.g* as the GOAL script. Notice that the output definition is simply an addition of the two input values. Thus, if the most suitable classes in both files are assigned high numbers, then the highest numbers produced by addition represent the best combinations of criteria. If the most suitable classes are given low numbers in one file and high numbers in the other, then this methodology does not produce logical results. You may modify this script by adding in weights if you wish. For example, input file 1 is bathymetry. If bathymetry is twice as important in placing a disposal site, then multiply *i1* by two before adding to *i2*. Modify the script to your liking, and then save it. Exit the Modify Script menu and submit the overlay process by selecting the check mark. The Overlay menu is dismissed. When the process is complete, load and display the resultant file using Grid Display Manager. Set the interval to one and create a legend for the map. Place descriptions with the legend showing which values are best- and worst-suited for placement of dredged material.

References

Bowie, W. (1928). "The triangulation of North America," *The Geographical Journal* 72, 348-56.

Byrnes, M. R., and Hiland, M. W. "Shoreline position and nearshore bathymetric change," and "Compilation and analysis of shoreline and bathymetry data," Chapter 3 and Appendix B, respectively, in *Kings Bay Coastal and Estuarine Physical Monitoring and Evaluation Program: Coastal studies, Volume 1: Main Text and Appendix A;* N. C. Kraus, L. T. Gorman, and J. Pope, ed., *Volume II: Appendices B-G,* N. C. Kraus and L. T. Gorman, ed., in preparation, U.S. Army Engineer Waterways Experiment Station, Vicksburg, MS.

Doyle, D. R., and Dewhurst, W. T. (1989). "North American datum of 1983," *Arc News* 11(4),14.

Intergraph Corporation. (1988). "Oracle SQL*Plus reference manual," Publication No. DNUC13820, Intergraph Corporation, Huntsville, AL.

______. (1991a). "MGE projection manager reference manual," Publication No. DJA054210, Intergraph Corporation, Huntsville, AL.

______. (1991b). "Microstation 32 reference guide," Publication No. DGA041710, Intergraph Corporation, Huntsville, AL.

______. (1991c). "Oracle SQL*Plus user's guide and reference," Publication No. DNA102010, Intergraph Corporation, Huntsville, AL.

______. (1992a). "CLIPPER System user's guide," Publication No. DSA030030, Intergraph Corporation, Huntsville, AL.

______. (1992b). "MGE terrain modeler reference manual," Publication No. DJA052440, Intergraph Corporation, Huntsville, AL.

______. (1992c). "MGE/SX reference manual, Volumes I and II," Publication No. DJA051180, Intergraph Corporation, Huntsville, AL.

Morgan, J. G. (1987). "The North American datum of 1983." *Geophysics: The leading edge of exploration*, 27-33.

Shalowitz, A. L. (1964). "Shoreline and sea boundaries, Volume 2," U.S. Department of Commerce Publication 10-1, U.S. Coast and Geodetic Survey, U.S. Government Printing Office, Washington, DC.

Snyder, J. P. (1987). "Map projections - A working manual," U.S. Geological Survey Professional Paper 1395, U.S. Government Printing Office, Washington, DC.

Tomlin, C. D. (1990). *Geographic information systems and cartographic modeling*. Prentice-Hall, Inc., Englewood Cliffs, NJ.

U.S. Coast and Geodetic Survey. (1957). "Horizontal control data 15," Special Publication No. 227, Washington, DC.

Wade, E. B. (1986). "Impact of North American datum of 1983," *Journal of Surveying Engineering* 112(1), 49-62.

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13. ABSTRACT (Maximum 200 words)

The general objective of the information management component of the New York Bight Study was to develop a District-based system (a geographic information system or GIS) to store, manipulate, and analyze the data sets associated with and developed by the New York Bight study. To accomplish this objective, the following efforts were required: database development, hardware/software acquisition, system installation, input of database attributes and graphic elements, and training of New York District personnel. Intergraph hardware and software were chosen as the system platform. Oracle database software was selected because it is one of the more common relational database management systems that provides comprehensive relational database (RDB) functions and data storage capabilities.

The selection of a base map projection and coordinate system was one of the first decisions made in the process of loading graphic data. Several files were loaded into the system including: digitized shoreline files, graphic representations of gauge locations, tide data, satellite images, model output for water surface elevation, temperature, salinity, and dissolved oxygen, wave hindcast data, and ship observation data.

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Appendix A presents a basic user training guide. Project training was focused to create geographic map displays from measured data and model output, and to perform analyses on these data. Training was performed in the manner that reflected the types of projects undertaken by the New York District and addressed problems or questions of interest to the New York District. The GIS/RDB techniques review can be used for future data collection and analysis requirements. Proper organization of these data and digital compilation of future data sets will increase the effectiveness of Corps decision-making procedures by providing instant access to all available information. In addition, hardware and software maintenance are addressed and estimated costs are quoted.